DOCUMENT RESUME

ED 055 419 EM 009 266

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TITLE	Educational Electronic Information Dissemination and Broadcast Services: History, Current Infrastructure and Public Broadcasting Requirements.
INSTITUTION	Washington Univ., St. Louis, Mo.
SPONS AGENCY	National Aeronautics and Space Administration, Washington, D.C.
REPORT NO	IM-71/3
PUB DATE	9 Aug 71
NOTE	91p.
EDRS PRICE	MF-$0.65 HC-$3.29
DESCRIPTORS	Audiovisual Communication; *Broadcast Industry; Broadcast Television; Cable Television; Closed Circuit Television; *Communication Satellites; Dial Access Information Systems; Educational Television; Fixed Service Television; *Information Dissemination; Information Networks; Information Retrieval; Information Services; Information Systems; *Instructional Television; Radio; *Telecommunication; Television
IDENTIFIERS	Corporation for Public Broadcasting; National Public Radio; Public Broadcasting Services

ABSTRACT

This memorandum describes the results of a study on electronic educational information dissemination and broadcast services in the United States. Included are detailed discussions of the historical development and current infrastructure (both in terms of organization and physical plant) of the following services: educational radio and television broadcasting, instructional television fixed services (ITFS), information retieval (dial access) television, and closed-circuit, responsive, and cable television. The creation of the Corporation for Public Broadcasting, the Public Broadcasting Service, and National Public Radio have made it possible to develop a national base and goals for nationwide coverage. These organizations have set forth their requirements in response to the recent filing of proposals with the Federal Communications Commission by eight organizations for owning and operating domestic satellite systems. After reviewing these requirements, the authors have set forth potential long-haul telecommunications requirements for public television and radio distribution. An appendix summarizes the key features of the eight proposals and comments on their suitability for meeting the requirements of public broadcasting. (Author/JK)

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PROGRAM ON APPLICATION OF COMMUNICATIONS SATELLITES
TO EDUCATIONAL DEVELOPMENT

WASHINGTON UNIVERSITY

Internal Memorandum No. 71/3

August 9, 1971

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HISTORY, CURRENT INFRASTRUCTURE AND PUBLIC BROADCASTING REQUIREMENTS

Jai P. Singh
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This research is supported by the National Aeronautics and Space Administration under Grant No. Y/NGL-26-008-054. This memorandum is primarily for internal distribution and does not necessarily represent the views of either the research team as a whole or the National Aeronautics and Space Administration.

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SUMMARY

This memorandum describes the results of a study conducted on electronic educational information dissemination and broadcast services in the United States. Included are detailed discussions of the historical development and current infrastructure, both in terms of organization and physical plant, of the following services: educational radio broadcasting, educational television broadcasting, Instructional Television Fixed Services (ITFS), Information Retrieval (Dial Access) Television (IRTV), Closed-Circuit Television, Responsive Television and Cable Television. All of the information dissemination and broadcast services described herein can currently be characterized as providing one-way transfer of information on a point-to-multipoint basis with the population of the receiving terminals being independent of the transmitter or origination point within the coverage area.

In the United States, a variety of electronic educational information dissemination and broadcast services have developed, reflecting the local character of U. S. education and a lack of resources and organization vis-a-vis commercial broadcasting. A series of maps have been plotted which indicate that these services, which include both intra- and inter-state television networks, are not distributed uniformly over the entire U. S. Certain areas--such as Alaska, the Rocky Mountain States and to some extent Appalachia--generally characterized as remote or rural areas, tend to have a dearth of services.

Public television and radio, representing one segment of electronic educational information dissemination and broadcast services, have in recent years developed a national organizational and networking base as well as goals for nationwide coverage. The creation of the Corporation for Public Broadcasting, the Public Broadcasting Service and National Public Radio have made it possible to develop this capability. These organizations have set forth their requirements in response to the recent filing of proposals with the Federal Communications Commission by eight organizations for owning and operating U. S. domestic satellite systems. After reviewing these requirements, and after considering key issues such as regional versus national versus special programming, we have set forth potential long-haul telecommunications requirements for public television and radio distribution. An Appendix to this memorandum summarizes the key features of the eight U. S. domestic satellite proposals and comments on the suitability of these proposals for meeting the requirements of public broadcasting.

CONTENTS

No.		Page
1.	Introduction.	1
2.	Educational Broadcasting.	2
	2.1 Educational Radio Broadcasting	2
	2.1.1 The Early Development	2
	2.1.2 Current Status.	6
	2.1.3 Subsidiary Communications Authorization	12
	2.2 Educational Television Broadcasting.	14
	2.2.1 The Early Development	14
	2.2.2 Current Status.	15
	2.2.3 Regional Networks	23
	2.2.4 Intra-State Networks.	27
	2.2.5 Instructional Television.	35
	2.2.6 Discussion.	38
	2.3 Special Television	40
	2.4 Closed Circuit Television and Instructional Television Fixed Service	42
	2.4.1 Introduction.	42
	2.4.2 Closed-Circuit Television	43
	2.4.3 Instructional Television Fixed Service.	45
	2.4.4 Closed-Circuit Networks	50
	2.5 CATV and Educational Television and Radio.	51
	2.6 Information Retrieval/Dial-Access Television	58
	2.7 Responsive Television.	60
3.	Public Broadcasting Program Distribution.	61
4.	References.	72
Appendix A	Analysis of Educational Telecommunications Needs: Service Categories	79
Appendix B	Some Comments on the Suitability of Eight Domestic Satellite Proposals for Meeting Public Broadcasting Requirements	81
	Table 1 Summary of Domestic Satellite Proposals	82

LIST OF FIGURES

No.		Page
1.	Growth of Educational Radio Stations in the United States. . .	7
2.	Distribution of Educational Radio Stations	8
3.	Distribution of National Public Radio Affiliates	10
4.	SCA and FM Spectrum Diagram.	13
5.	Growth of ETV Stations	16
6.	Distribution of Educational Television Stations.	17
7.	Inter- and Intra-State Educational Communication Networks. . .	29
8.	Distribution of ITFS Installations	49
9.	Growth of CATV Households.	52
10.	Growth of CATV Operating Systems	52
11.	Projected Growth of Cable TV	57
12.	Projected CATV Service Areas in 1975	59
13.	Proposed Public Broadcasting Originating Points.	63
14.	Time-Zone Operations by Terrestrial Links Only	65
15.	Time-Zone Operation by Satellite Links	66

LIST OF TABLES

No.		Page
1.	Distribution and Ownership of ETV Broadcast Stations	18
2.	Hours Per Week of Operation of State ETV Systems	19
3.	Days Per Week of Operation by State ETV Systems	20
4.	Regional ETV Networks	24
5.	Intra-State Interconnection Facilities	28
6.	PBS Survey of 15 State Educational Telecommunications Networks	30
7.	Number of CCTV Installations by Type in 1967	44
8.	Frequency Assignment for Instructional Television Fixed Service (ITFS)	46
9.	Ownership and Distribution of ITFS Systems	48
10.	Potential CATV/Wired City/Broadband Communication System Services	56
11.	Public Television Service	70
12.	Public Radio Service	71

EDUCATIONAL ELECTRONIC INFORMATION DISSEMINATION AND BROADCAST SERVICES: HISTORY, CURRENT INFRASTRUCTURE AND PUBLIC BROADCASTING REQUIREMENTS*

1. INTRODUCTION

Washington University has undertaken a NASA sponsored program on application of communications satellites to educational development within the United States.[110] A major objective of the program is to investigate and devise systems and strategies for improving education utilizing communications satellites. An essential foundation for the systems synthesis phase of the work is an analysis , in as quantitative terms as possible, of the wide variety of educational/instructional services which are possible using telecommunications and a determination of future requirements for such services.

For the purposes of systems synthesis, one has to have detailed information, to the extent fullest possible, regarding the telecommunications infrastructure that already exists--especially the dedicated type designed to provide exclusive educational services--planned extensions to it, any growth trends that might be traced through the history of the usage of a particular service, and social, economic, political and technological factors that could potentially influence the existing trend.** In addition, one also needs to know the estimated demands for various services utilizing telecommunications over a certain period of time in the future, the type of message that will be transmitted--video, voice, analog/digital--the data rate, message duration, geographical distribution of messages, technical quality or performance requirement for the messages (Signal-to-Noise ratio at the receiver output or a certain probability of error in decoding digital data stream), and the coverage area.

For the purposes of analysis, educational/instructional telecommunications requirements/demands can be grouped under the following three broad service categories (see Appendix A):

a) Information Dissemination and Broadcast Services: Broadcast Radio and Television, Instructional Television Fixed Services (ITFS), Closed Circuit TV installations (CCTV), Cable Television (CATV), Information Retrieval Television (IRTV) and Responsive Television (RTV) etc.

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* This is one of a series of memoranda on educational telecommunications needs. The authors wish to thank Mr. Robert R. Bruce of Public Broadcasting Service for providing the results of the PBS survey of 15 state ETV networks, and Mrs. Emily Pearce and Miss Barbara Morose for the very skillful typing of the manuscript.

**A recent Satellite Education Program report[105] surveys the physical characteristics and costs of selected communications media and educational technologies but does not examine telecommunications infrastructure per se.

b) Interactive Telecommunications Services: Teleconferencing, on-line information retrieval, remote time-sharing, computer-based instruction, etc.

c) Computer Interconnection Services: Remote batch processing, resource sharing, distributed intelligence, etc.

In this memorandum we have surveyed the existing infrastructure of the services falling in the first category, i.e. Information Dissemination and Broadcast Services for both public and instructional use. The historical development of these services has also been discussed briefly for future planning. Also presented are discussion and estimates of long-distance telecommunications requirements for Public Radio and Television for program distribution, program assembly, advance preview of programs, and on-spot live coverage of special and sports events. Estimates for long-distance telecommunications requirements for the instructional segment of the services* will be presented in a forthcoming memorandum.

2. EDUCATIONAL BROADCASTING

2.1 Educational Radio Broadcasting

2.1.1 Early Development

The history of educational radio, as well as that of educational broadcasting, begins in 1917 when the University of Wisconsin constructed Station 9XM, the nation's pioneer educational radio station, relicensed in 1921 as WHA.[1] Prior to the beginning of regional programs in 1921, the activities of 9XM (now known as WHA) were limited to point-to-point conversations with other experimental units throughout the country.[2] In 1921, radio stations were operated by the Universities of Wisconsin, Iowa, and Nebraska. Michigan State University has had an educational radio station since 1918, first on experimental basis and then regularized in 1922, which continues to provide extension services for the rural population. Also, in 1922, the University of the State of New York was completing plans for broadcasting lectures which were to be received through loud-speakers in various classrooms.

The credit for the first real educational courses carried on by radio transmission is awarded to the Massachusetts State Department of Education, Division of University Extension. The courses were begun in

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*The term "public educational information dissemination and broadcast services" is used throughout this report to describe services intended for general public use whereas "instructional services" is intended for formal instructional purposes in schools, colleges, etc. For example, according to current usage, educational television (ETV) is defined as being made up of public television and instructional television, i.e. ETV = PTV + ITV. "Special television/radio" is used in this report to designate public and instructional services to minority groups, be they cultural, ethnic or professional.

September 1923, and were conducted for four years. During this time 4,530 persons enrolled in 21 different subjects.[2] The subjects offered included languages, music appreciation, psychology, English literature, American literature, home economics, law, journalism, etc.

While both educational and commercial radio broadcasting were progressing and spreading at an enormous pace in the period 1922-1929, the field was plunging into chaos due to the lack of proper and effective regulatory organization. At the request of a conference of radio interests in Washington in March 1923, the Secretary of Commerce began to assign a specific frequency to each station and to limit power and hours of operation to accommodate more stations. However, grave questions were raised as to whether the 1912 law concerning marine radio communication gave the Secretary the discretionary power to issue licenses. The House Committee on the Merchant Marine and Fisheries declared in reporting out the bill that it did not give the Secretary such power.[3] In 1912, the Attorney General rendered an opinion to the same effect, holding that the Secretary lacked the power to refuse to grant a license to a corporation.[4] A 1926 court decision removed even the authority over assignment of a particular frequency by the Secretary of Commerce.

On July 1, 1926, 528 broadcasting stations were operating on the 90 available channels.[4] Many of these were ignoring completely their assigned frequencies and power assignments, with the invariable result that chaos reigned, and it was a fortunate listener who could tune to the station of his choice without receiving interference from other unwanted stations. Things went so out of control that 41 stations in the United States began using the six channels that had been reserved for the exclusive use of Canadian stations despite appeals from Cabinet members, who pleaded that national good faith and international goodwill were at stake.[5]

Following the breakdown of regulation in 1926, all parties concerned, including the broadcasters, favored the prompt enactment of new legislation to save the developing industry from chaos and the listener from a headache. The result was the creation of the Federal Radio Commission under the limited control of the Executive Branch of the government, with powers to classify radio stations, to prescribe the service each class should render, to assign frequencies to classes and to individual stations, to determine each station's power and hours of operation, to regulate the kind of apparatus to be used, and to prescribe regulations to prevent interference. However, at that time, certain administrative functions were retained by the Secretary of Commerce--receiving applications from operators or licensees, prescribing qualifications of station operators, inspection of transmission apparatus to ensure conformity with the regulations, designation of call letters, and reporting of violations to the Federal Radio Commission (FRC). In July of 1932, Congress acted to transfer all duties and functions of the Radio Division of the Department of Commerce to the Federal Radio Commission (FRC).

It must be noted that the FRC only had authority over non-federal radio--commercial, private or marine. The Interstate Commerce Commission was handling long-lines and the Postmaster General had authority over

tariffs for telegraph and telephone company facilities for federal agencies. In addition, the President had authority to assign frequencies for the use of radio stations owned and operated by federal government agencies. In 1933, the Secretary of Commerce, at the suggestion of the President, established a committee to undertake a comprehensive study of the regulation of communications. The recommendations of this committee resulted in the enactment of the Communications Act of 1934 and the creation of the Federal Communications Commission.

While these developments were taking place, educators were not sitting by idly. In the year 1929, the first National Conference on Education by Radio was called and an extensive campaign was started by educators against continued absorption of educational radio facilities by commercial broadcasters. Based on the recommendations of a 1926 committee investigating the uses of radio in education, the Secretary of Interior appointed the National Advisory Committee on Education by Radio (NACER) to make a national survey of all radio stations. On December 30, 1929, the committee submitted its recommendations that a section devoted to radio be established and financed as part of the Office of Education, then a part of the Department of the Interior, to examine and to determine the causes of any conflicts with commercial interests, and to carry on at the same time an inclusive research program directed towards perfecting the use of radio for educational purposes.[6] The adoption of this report was the beginning of planned progress in the area of educational radio (ER).

The U.S. Commissioner of Education called a national conference on Radio and Education in Chicago on October 13, 1930 at the request of radio stations operated by various state governments, schools, colleges, universities and other non-profit organizations. That committee recommended, as a part of its program, (a) that legislation be enacted to assure the assignment of broadcasting frequencies with a block reserved for educational use; and (b) that a committee of educators be appointed to formulate definite plans for the promotion of educational broadcasting. In December 1930, the proposed committee was appointed and designated as The National Committee on Education by Radio (NCER).

During the period from 1920 to 1930, schools, colleges, and universities constructed at least 176 radio stations. Properly speaking, a great many of these were not educational broadcasting endeavors, but experimental projects in transmission technology by departments of physics and electrical engineering.[1] By the mid-thirties, following the economic crash of 1929, only 35 of these stations remained. Significantly, most of the survivors were located on the campuses of land-grant universities where a commitment to off-campus education and to programs of extension education was a chartered obligation under the Morrill Act which created these institutions. The radio station managers of these land-grant universities comprised the leadership of the National Association of Educational Broadcasters (NAEB), which later spearheaded the effort to reserve FM and TV channels for education. In the early days, pioneering roles in the development of educational radio were played by Ohio State, Michigan Agricultural College (now Michigan State), and the Universities of Illinois, Wisconsin and Iowa State.

During the debates on the Communications Act of 1934, the educational lobbying forces were strong enough to create sentiment in favor of directing the FCC to reserve 25 percent of all broadcast facilities for the exclusive use of non-profit organizations.[7] Although this did not materialize, in its final form the Act did direct the FCC to study the allocation of fixed percentages of radio broadcasting facilities to particular types or kinds of non-profit activities. The deadline given to the FCC for reporting back to the Congress was February 1, 1935.

However, after hearing representatives of commercial broadcasters and networks, educational institutions, labor organizations, etc., the Commission recommended to Congress that no specific percentage of broadcast facilities be allocated for the use of non-profit organizations because commercial stations were able and willing to make their facilities available to such organizations. The Commission argued that this would better serve the latter by giving them access to expensive and efficient equipment and to established audiences. The Commission urged, however, the commercial broadcasters be required to cooperate, and declared that it would "assist the non-profit organizations to obtain the fullest opportunities for expression".*[20]

Pursuant to this pledge, the FCC established the Federal Radio Education Committee (FREC) under the Chairmanship of the Commissioner of Education to promote actual cooperative arrangements between educators and broadcasters on the national, regional and local level. FREC was relatively inactive and impotent in early days, although it did undertake some studies regarding the manner in which non-profit organizations could best serve radio listening audiences.[1]

Though no exclusive allocations were made for an AM-radio service for education, broadcasting stations have been licensed directly to non-profit organizations including educational institutions and city and state governments. At first, the FRC had taken the view that government stations are not entitled to priority of consideration by virtue of the fact that the licensee is a public corporation.[11] This decision was first taken in the case of the reapplication of the University of Wisconsin and was upheld in a court of law in the case of a New York City municipal station.[12] However, the first victory of the united educational forces came in January 1938, when the FCC announced the establishment of a new

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*In the early days of radio broadcasting, particularly during the period between the inception of AM broadcasting and the birth of FM radio, commercial radio did play an important role in bringing to American children, as well as many adults, many programs which could legitimately be called educational. Some of the early roles of commercial radio in educational broadcasting, including programs for in-school use, are documented elsewhere.[8,9] Commercial Networks, CBS and NBS had separate sections for educational programming and featured such famous series as the American School of the Air, Music Appreciation Hour, America's Town Meeting of the Air, Sunday Concerts of the Philharmonic Society of New York, Music Makers, Youth Health, Ideas that Came True, etc. Local commercial outlets also made time available for the express purpose of providing instructional programming for local schools.

kind of broadcast station which it called "non-commercial educational". These stations are licensed only to organized nonprofit educational agencies for use in advancing their own educational programs. In addition to this primary function, they may be used to transmit information regarding administrative matters to several units of a school system or to broadcast educational programs and entertainment to the general public. The service must be on a nonprofit and noncommercial basis, and programs originating in commercial stations may not be rebroadcast unless commercial announcements are eliminated.[13] No definite schedule or minimum hours of operation are required.[14]

2.1.2 Current Status

In the late 1930's, Major E. H. Armstrong devised a new method for aural broadcasting which was to be known as Frequency Modulation (FM). This technique made possible the transmission of high quality and high fidelity audio. In 1940, the FCC made available an eight megahertz wide allocation (42-50 MHz) for FM experimentation and in the same year it incorporated in its rules that noncommercial broadcast stations should employ frequency modulation "unless it is shown there is a special need for the use of amplitude modulation (AM)".[15] This service was assigned a band of frequencies adjoining the then existing FM broadcast frequencies. When commercial FM services were moved to a higher band (92-108 MHz) in 1946, the noncommercial services were moved with it, enabling any listener who has an FM receiver to tune to the noncommercial programs as well. This action resulted in the reservation of the 88.1-91.9 MHz portion of the standard 88-108 MHz FM broadcast band for the exclusive use of educational stations. The 88.1-91.9 MHz band accommodates 20 channels known as channels 201-220.[16] Channel 206 (89.1 MHz) has also been made available to the United Nations in New York City and the FCC has decided against any allocations that would interfere with the operation of the U.N. station. In Alaska, the frequency band 88-100 MHz is allocated exclusively to Government Radio Service and the non-government fixed service, and 100.1 - 107.9 MHz (channels 261 through 300, inclusive) is shared by noncommercial FM with commercial FM.[16]

Educational noncommercial FM broadcasting stations can be divided into two major categories: (a) those operating with no more than a 10 watt transmitter power output (Class D); and (b) those operating at transmitter power in excess of 10 watts. Class D stations are meant for on-campus listening.

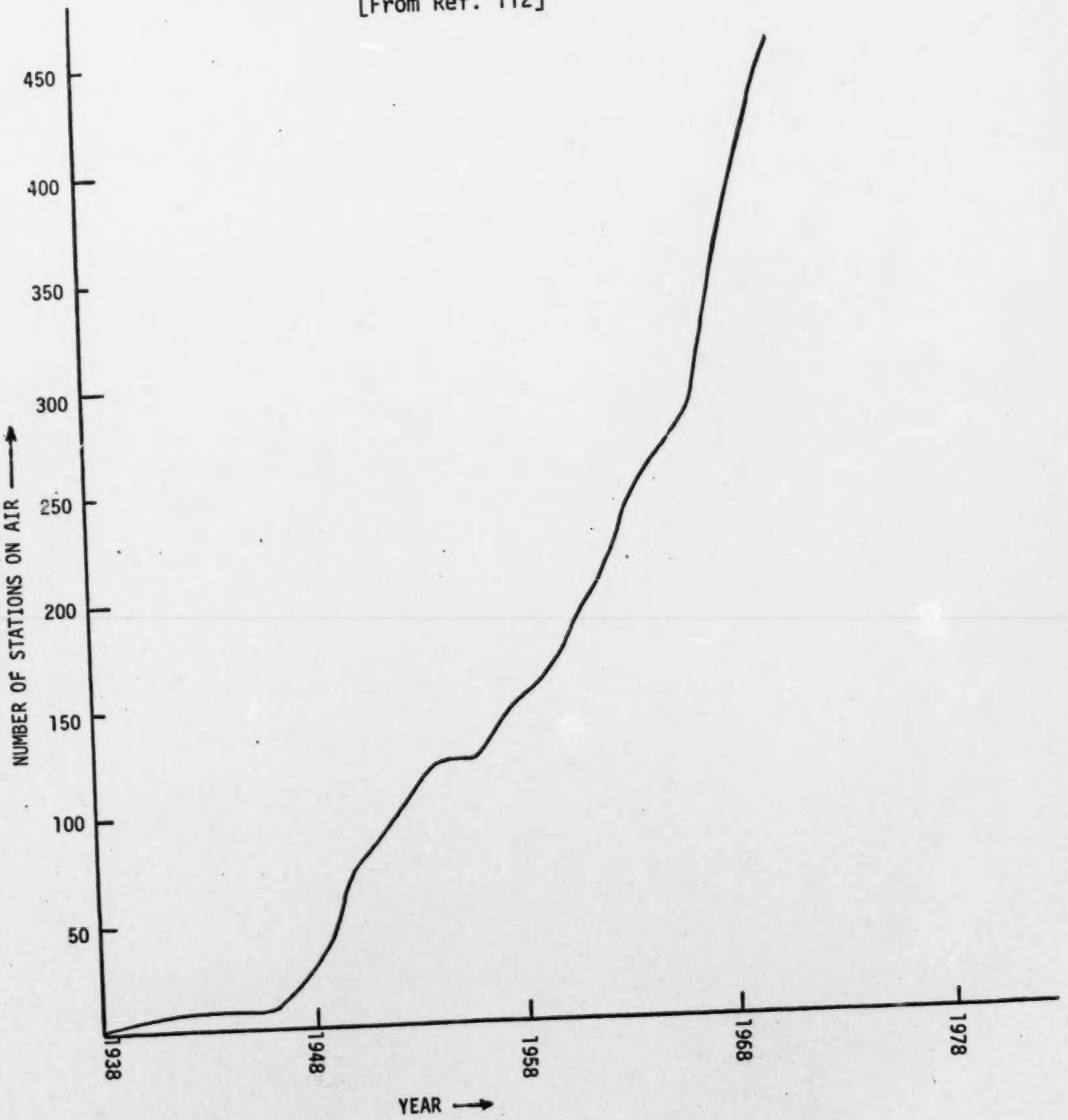
Figure 1 shows the growth of educational radio broadcasting in the United States since 1938 when for the first time the FCC established a new class of stations known as "noncommercial educational" stations. As is evident from the growth curve, the real take-off point came with the advent of FM broadcasting in the late 1940's. Unfortunately, it was again overshadowed by the growth of television and very much became "the hidden medium".[18]

As of December 1970, there were 457 educational radio stations in the United States. Figure 2 shows their geographical distribution. Of these, 25 were AM stations and 432 were FM.[17] Nearly two dozen of the

Figure 1

GROWTH OF EDUCATIONAL RADIO STATIONS IN THE UNITED STATES

[From Ref. 112]



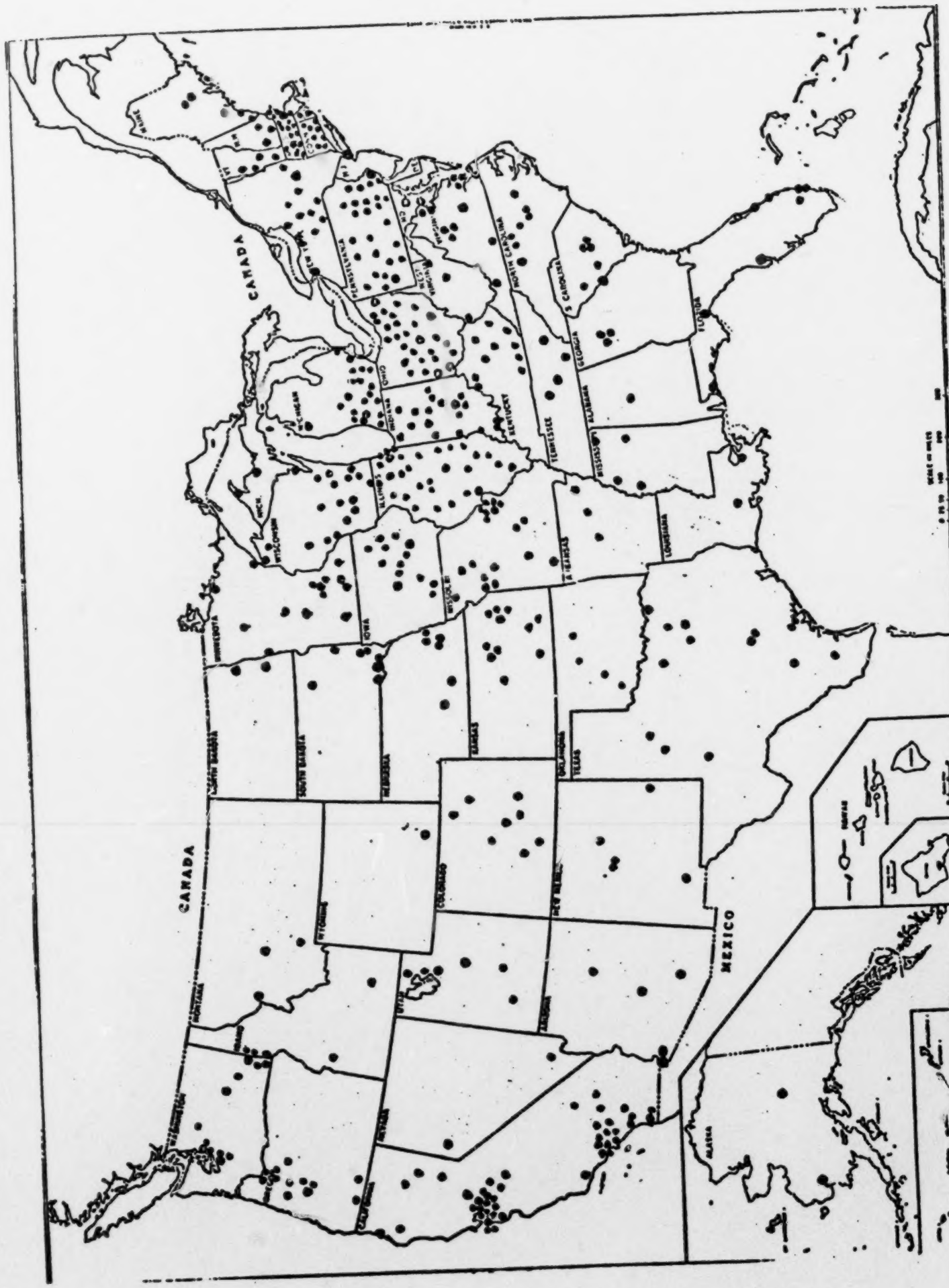


Figure 2
DISTRIBUTION OF EDUCATIONAL RADIO STATIONS

FM stations were operating on unreserved frequencies. A high percentage of the radio stations broadcast limited schedules on limited power. Of these 432 FM stations, 273 were Class D stations limited to 10 watt transmitter power-output.

Of the current ER station "population" of 457, approximately 71% are licensed to colleges and universities, some 15% to public school systems, and the remaining licenses are shared by independent schools, theological institutions, state councils, educational organizations, public libraries and municipalities. The dominant group of licensees is the colleges and universities. The nature of licensee organizations is reflected in the nature of their programming. The colleges and higher educational authorities have used their stations for cultural enrichment, extension training, student training and, in a few cases, for student teaching. In addition, they see their stations as having a public relations purpose.[18] The school districts focus upon direct teaching and supplementary instruction. The nonprofit organizations and public libraries are primarily concerned with adult education, particularly cultural enrichment, and the theological groups generally favor informal adult education, with a few accentuating religious education.

The Corporation for Public Broadcasting (CPB) has established a list of criteria on "what a public ER station is" as far as its services and assistance is concerned. The requirements include a transmitter power output of more than 250 watts for both AM and FM, a program origination studio, equivalent of three full-time professional staff members, minimum on-air time of 48 weeks/year, 6 days a week and 8 hours a day, and a broadcast schedule in which at least half of the station's output be devoted to informational and cultural programming. Of 457 ER stations, only 92 stations meet these requirements. Figure 3 presents the geographical distribution of these major ER stations, affiliated with National Public Radio.

It becomes evident from Figures 2 and 3 that some areas of the country are well covered and some are very poorly covered. The northeastern quadrant is generally blanketed with educational radio licensees (at least in the major metropolitan centers), as is much of the Great Lakes region and the major cities of the West and Pacific coast. But the Southeastern and Southwestern states, along with a number of Plains and Rocky Mountain states are inadequately covered. In short, there is a need to fill in the gaps in existing coverage if all areas of the United States are to be provided with educational radio services.

Until recently, most ER stations were affiliated with either or both of the following two organizations: (a) National Educational Radio (NER), a division of the National Association of Educational Broadcasters (NAEB), and (b) National Educational Radio Network (NERN). The National Educational Radio Network (NERN) is neither an interconnected network nor one which does any centralized production of network programs. Instead, NERN is a national organization of educational radio stations served through the distribution of tape recorded programs by network headquarters in Urbana, Illinois. NERN has been a self-supporting operation through the payment of fees by affiliates for the last 15 of its 23 years. It provides its affiliates with a minimum of 865 hours of new programming per quarter. Other networks serving educational stations include the Broadcasting Foundation of America, which distributes programming services from abroad

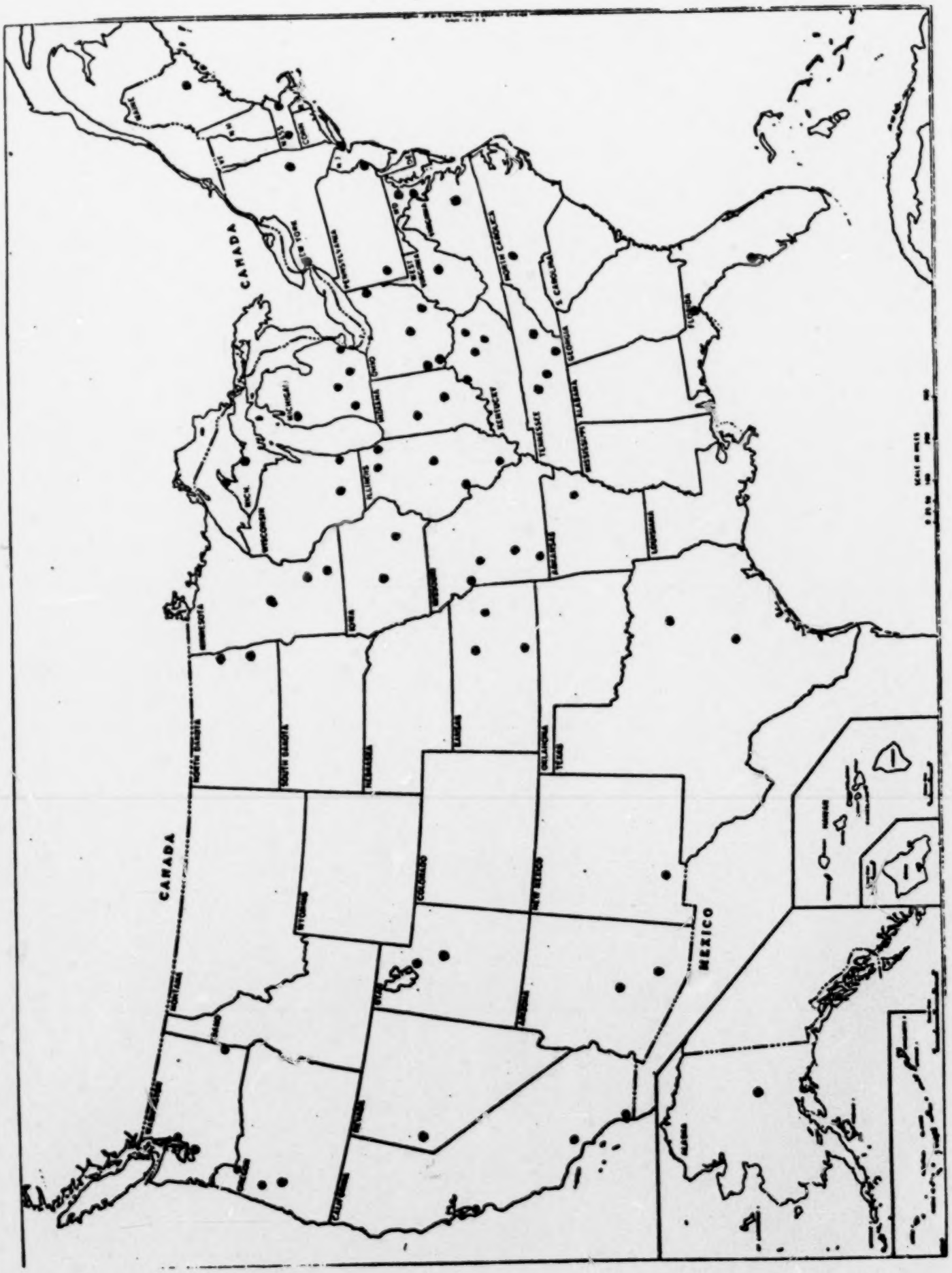


Figure 3

DISTRIBUTION OF NATIONAL PUBLIC RADIO AFFILIATES [From Ref. 17]

to U.S. stations; Eastern Educational Radio Network (EERN)--a group of Eastern Radio stations which exchange taped programs, cooperate in the production of shows and interconnect lines for some broadcasting; and the Intercollegiate Broadcasting System, which serves mainly carrier-current campus operations with about four and three-fourths hours of material per week.[18]

In addition to the regional networks discussed above, as of April 1967 many states were moving ahead with plans for statewide educational radio networks and state-wide coverage. The only comprehensive study on the status of ER dates back to 1967[18] and at the time the study was conducted, Colorado, Iowa, Michigan, Minnesota, New York, Ohio, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Washington and Missouri were states in which plans for full-coverage radio networks were in various stages of development. No information on the current status of radio networks in these states is available. However, it should be noted that the development of state ETV networks has provided new opportunities for the statewide interconnection of ER stations. A network for any single wideband communication medium such as television can be the substructure upon which other narrow-band media such as radio, slow-scan/still-picture television, etc. can be constructed at relatively low marginal cost.

Early in 1970, the Corporation for Public Broadcasting formed National Public Radio (NPR), Inc., a nonprofit corporation funded by CPB for the principal purpose of providing a national network program service to the non-commercial public radio stations of the United States. Membership in NPR is open to any institution or organization which operates a non-commercial, public radio station in the United States and its territories. Membership is contingent upon meeting the qualifications discussed earlier which have to do with station program philosophy and policy, local production capability as measured by staff and facilities, and access to a significant body of potential listeners as measured by antenna power and length of broadcast schedule.[19]

As of April 1, 1971, membership in NPR numbered 85 institutions operating a combined total of 92 AM and FM transmitters. The largest group of member stations, 68, are operated by colleges and universities. Public non-profit organizations operate 7 of the NPR member stations. Seven stations are operated by public and private school systems, two by public libraries; and one by a municipality. These stations have access to about 48 million people in their coverage area. NPR expects that by the end of 1971, membership will increase to 108 institutions operating nearly 137 transmitters.[19]

On May 3, 1971, NPR initiated an interconnection of its affiliates using AT&T facilities. Interconnection service will largely consist of coverage of public events, issues and ideas as well as acquired and produced special public affairs programs. The interconnection system will permit some 28 member stations to insert their programs in the national network. However, the present limitation of the system to 5 kHz total bandwidth (some parts limited to 3.5 kHz) precludes live distribution of musical and stereo programs. NPR is also engaged in the planning of an experimental satellite interconnection of its members in Alaska and Puerto Rico.

NPR is also planning for the implementation of a library service in the later half of 1971 for program exchange of locally produced programs among all public radio stations. A library facility in Washington, D. C. will act as a depository for NPR programs requiring stereo or high-fidelity reproduction. NPR plans to operate a scheduled tape service using the mails for delivery.

Today, the educational, non-commercial, non-profit radio stations have begun to respond to the new challenges posed to them and also have started to innovate. School stations are hoping to expand their service beyond the limits of conventional classroom and the common curriculum. They are bringing to young people the professional insight of physicians and psychiatrists into the problems of alcoholism and drug addiction, the knowledge of local executives in helping school age citizens make realistic vocational plans, and cultural programs like the Spring Shakespeare Festival. Educational radio is turning towards forgotten audiences such as the mentally retarded, young criminals, the culturally and economically disadvantaged, and young mothers.

2.1.3 Subsidiary Communications Authorization

The new technique of multi-channel multiplexing,[21] authorized under Subsidiary Communications Authorization (SCA) awarded by the FCC to FM radio operators in 1955, has offered the hope of meeting varied needs, even in view of spectrum overcrowding, by transmitting multiple signals using a single transmitter. Each FM channel is allocated 200 kHz of spectrum, 100 kHz on each side of the allocated frequency. Of the 200 kHz, only 30 kHz are used for the FM main channel, 15 kHz on either side of the station's assigned frequency. There are two guard bands at the outer ends of the channel, each occupying 25 kHz bandwidth. This leaves 120 kHz (60 kHz on each side of the assigned frequency) to be used for auxiliary transmissions on the FM channel.

Figure 4 shows a typical spectrum assignment for an FM channel and for SCA. When transmissions are made in stereo, stereo signals occupy an additional 60 kHz of bandwidth and only 32 kHz is left for SCA transmissions.[22] When stereo is broadcast by the FM station, the FCC allows transmission on only one SCA channel. Without a stereo signal, however, two SCA subchannels may be added to the main FM channel program.

SCA programs can not be received on conventional FM radio sets. Special receivers cost as much as 10 times the cost of the lowest cost AM/FM receivers. These receivers are not available to the general public since, according to the FCC definition, SCA is a non-broadcast function, equivalent to a private point-to-point communication service giving each station control over its SCA transmissions. However, this offers a convenient format for transmitting specialized programs for specialized audiences--information that is not designed for the general public and must be, somehow, stopped from reaching them. SCA has already been used to provide credit courses at high school level[22] and for providing medical information to physicians.[23] A number of applications using SCA, including facsimile transmission of newspapers and of detailed medical histories to home as well as for education at home are being contemplated.[24,25]

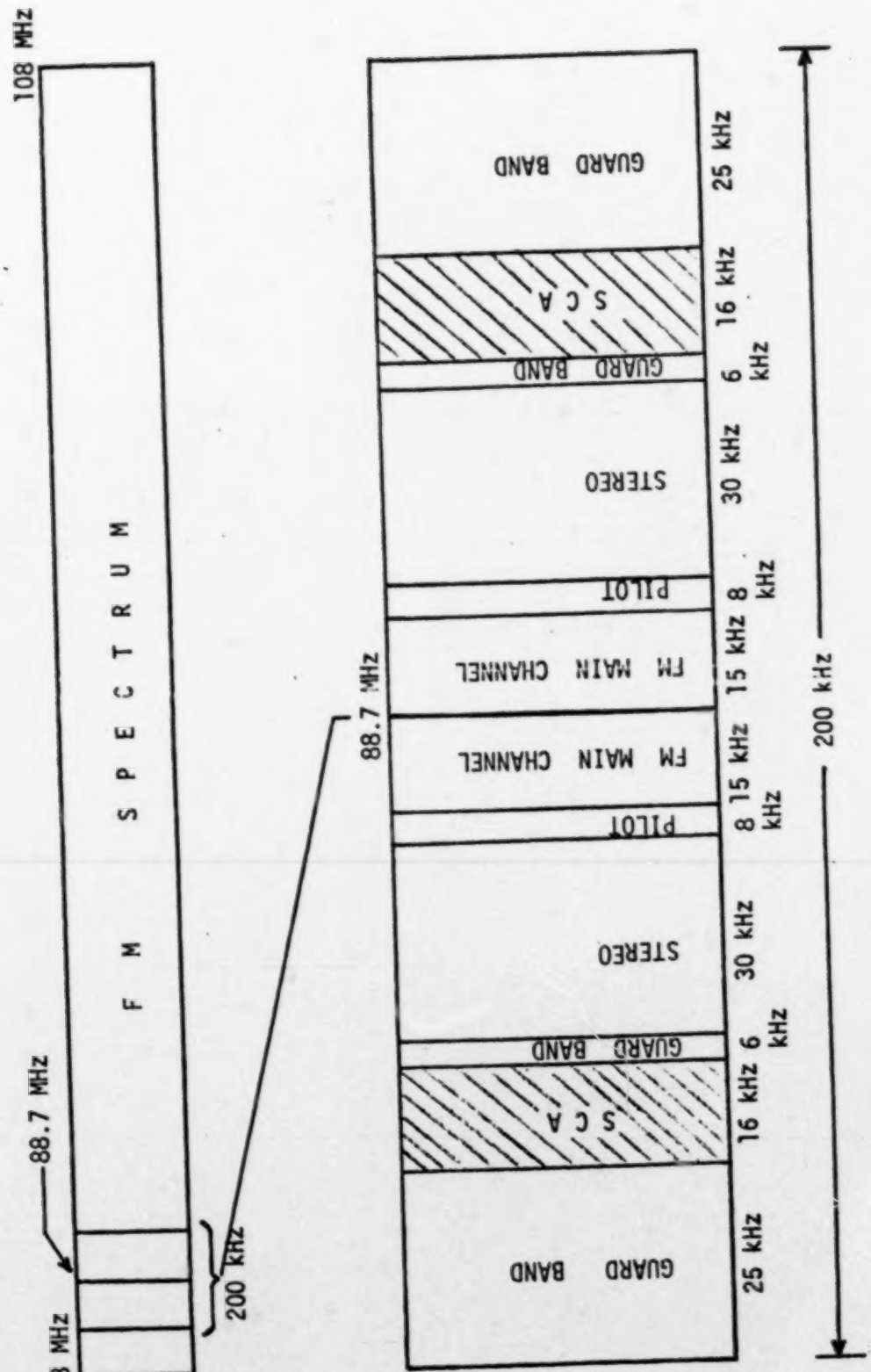


Figure 4. SCA AND FM SPECTRUM DIAGRAM

2.2 Educational Television Broadcasting

2.2.1 The Early Development

The beginning of educational television (ETV) in the United States is traced to Station W9XK, an experimental station developed by the State University of Iowa electrical engineering department, which broadcast its first program in 1932.[1] Using a "scanning disc" system instead of an electronic scanning tube like Orthicon or Vidicon, the station between 1932 and 1939 transmitted more than 400 programs including lecture courses in art, shorthand, engineering and botany as well as drama and other entertainment.

After the Second World War ended, television captured people's interest and by 1946 there were six regularly authorized, non-experimental stations in the United States reaching 6,500 receivers. By 1948 there were 40 commercial stations in operation and 600,000 receivers in use. However, until then there were no ETV stations. The year 1948 saw the pioneering effort of five U.S. educational institutions in the field of ETV. They were the University of Iowa (Iowa City), Iowa State University (Ames), Kansas State University, The University of Michigan, and American University.[1,25] The first nonexperimental, educationally owned television station in the United States was WOI-TV at Iowa State University which went in air in February 1950 as the 100th television station in the United States.

In 1948, the Federal Communications Commission (FCC) announced a "freeze" over television licenses so that it could develop a comprehensive plan for frequency assignments. In 1950, the FCC came out with its channel allocation plan without any exclusive reservations for ETV. Frequency allocation hearings in 1951 held by the FCC afforded educators an opportunity to bid for frequency allocations for educational purposes. Koenig[25] has documented the plight of educators during this period. A major problem was the emergence of unorganized, and contradictory pleas from different educational groups. Some educators wanted nonprofit educational television while others wanted noncommercial ETV, and still others wanted both. Through the efforts of the radio chief for the U.S. Office of Education and the president of the National Association of Educational Broadcasters (NAEB), educators were brought under a single umbrella by forming an ad hoc Joint Committee on Educational Television. Educators jointly called upon the FCC to reserve a number of television channels for the exclusive use of education--channels to be operated as both nonprofit and noncommercial undertakings. In April 1952, the FCC established a new kind of broadcast entity, the noncommercial, nonprofit educational television station, and reserved 242 channels (80 VHF and 162 UHF) for the exclusive use of ETV. By 1966, these allocations had been increased to 116 VHF and 516 UHF channels. KUHT, jointly licensed to the University of Houston and the Houston Board of Education, was the first nonprofit noncommercial station to go on air (May 12, 1953) under the Sixth Report and Order of the FCC in the matter of TV frequency allocations.

2.2.2 Current Status

Figure 5 presents the growth of ETV in the United States to date and projects future growth to match commercial TV population coverage. Figure 6 shows the geographical distribution of ETV stations. Most ETV stations are located in the densely populated areas, especially in the eastern part of the country. Certain areas have access to two ETV channels whereas large areas of the central and western states do not have any ETV coverage. Three states, Alaska, Montana and Wyoming, do not have any ETV stations. Some 74% of the American people are capable of receiving ETV signals.[7]

Today there are some 204 ETV outlets on the air as compared with 140 in 1967 and 62 in 1962. Another 6-10 are under construction. Of these 204 outlets, some 43% are licensed to state and local educational systems, 32% to universities or colleges and the remainder to community organizations (see Table 1). Stations operated by state agencies receive about 95% of their funds from state appropriations. Those operated by the colleges, universities and school systems obtain about 75% of their income from direct budget support whereas community ETV stations depend upon gifts, grants and compensation for production of in-school programs for 75% of their support.[27]

Stations licensed to school systems are primarily involved with instructional programming. A typical school system goes off the air in the early evening each day after broadcasting special programs for teachers and a few NET tapes for children and adults at home. Though the FCC demands that ETV licensees "meet the educational needs" of the communities they serve, the programming schedule of stations operated by school systems is very unbalanced in favor of in-school programming. School systems operating the station feel, perhaps very rightly, that their responsibility is mainly to the schools and they do not have the money for anything else. Teachers and principals like the television service, or so they say at meetings, but the use of the medium in most schools remains far from intensive and the word "supplementary" is common in description of the service .[28]

Stations licensed to state agencies have, in most cases, a well balanced program schedule. According to the Frymire Survey[29] conducted for the Corporation for Public Broadcasting, state ETV systems devote some 52% of their on-air time to public television programs, 42% to in-school instructional programs and the remaining 5% to continuing education, adult industrial training, etc. (see Table 2). Eleven out of twenty-four state ETV systems operate six days a week. Four state systems operate five days a week and only seven operate during all seven days (Table 3).

The ETV stations licensed to universities are more oriented towards public television programming. A good many of these stations have contracts with the local board of education and almost 30 percent of their programming is specifically for in-school use. A few series are aimed at college students and professionals, and the rest of the offerings are for the entire community.[28]

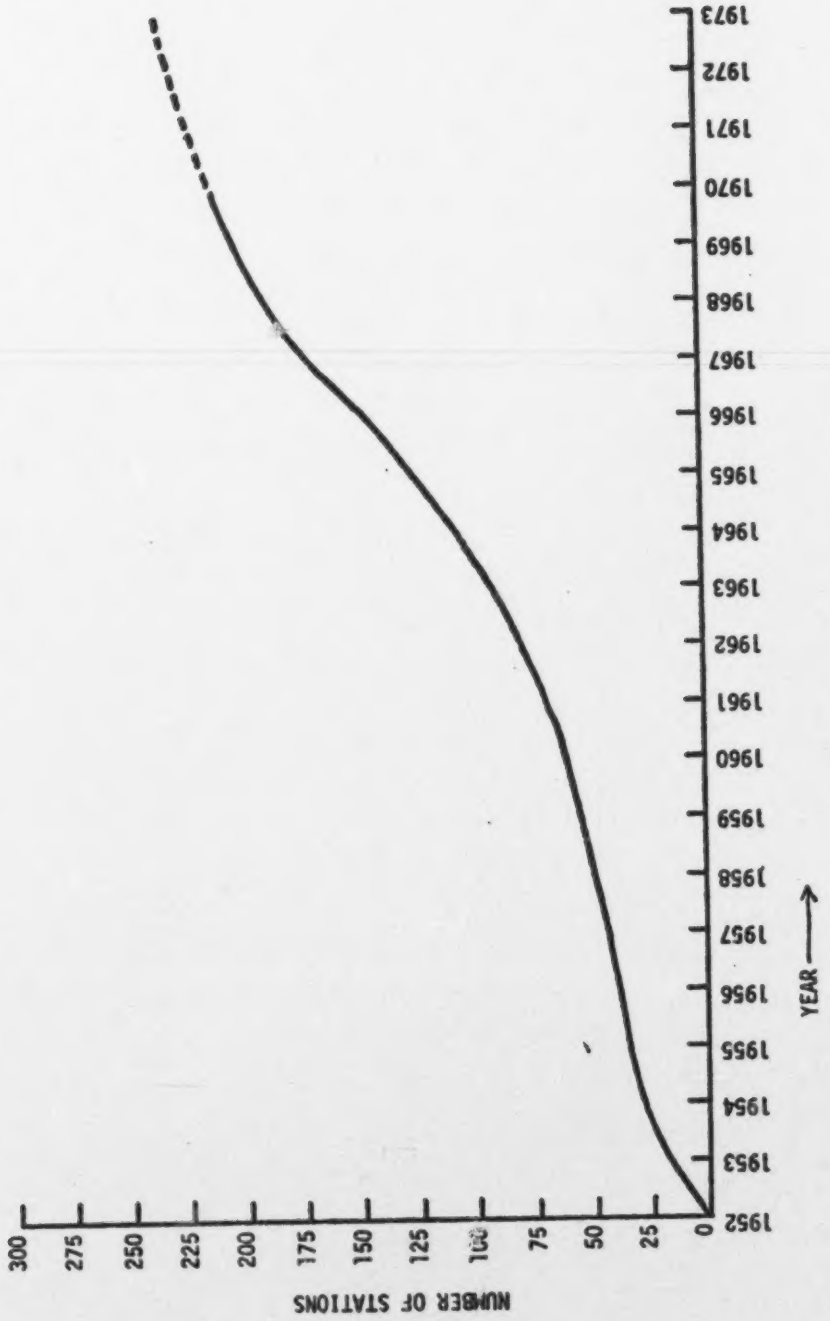


Figure 5. GROWTH OF ETV STATIONS [Ref. 112]

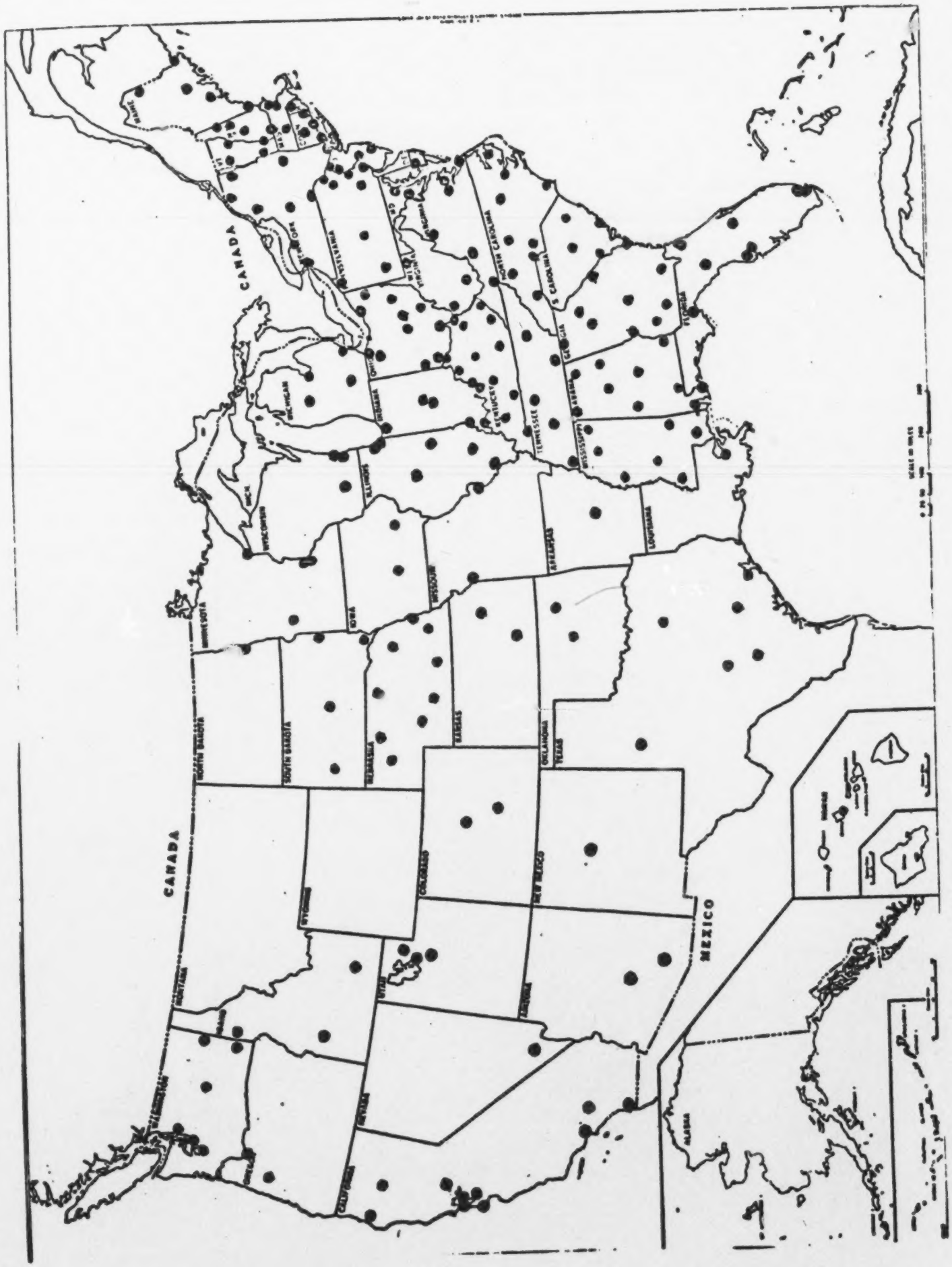


Figure 6 DISTRIBUTION OF EDUCATIONAL TELEVISION STATIONS [From Ref. 17]

TABLE 1

DISTRIBUTION AND OWNERSHIP OF ETV BROADCAST STATIONS

STATE	STATE OWNED STATIONS	UNIVERSITY OWNED STATIONS	COMMUNITY OWNED STATIONS	JUNIOR COLLEGE OWNED STATIONS	SCHOOL DISTRICT OWNED STATIONS	COUNTY OWNED STATIONS	TOTAL
ALABAMA	9	0	0	0	0	0	9
ALASKA	0	0	0	0	0	0	0
ARIZONA	0	2	0	0	0	0	2
ARKANSAS	1	0	0	0	0	0	1
CALIFORNIA	0	1	6	2	0	1	10
COLORADO	0	0	0	0	1	0	1
CONNECTICUT	0	0	3	0	0	0	3
DELAWARE	0	0	1	0	0	0	1
DISTRICT OF COLUMBIA	0	0	2	0	0	0	2
FLORIDA	0	3	4	0	0	3	10
GEORGIA	8	1	0	0	1	0	10
HAWAII	0	2	0	0	0	0	2
IDAHO	0	2	0	0	0	0	2
ILLINOIS	0	3	2	0	0	0	5
INDIANA	0	2	1	0	2	0	5
IOWA	2	0	0	0	0	0	2
KANSAS	0	1	1	0	0	0	2
KENTUCKY	12	0	0	0	0	1	13
LOUISIANA	0	0	1	0	0	0	1
MAINE	0	3	1	0	0	0	4
MARYLAND	2	0	0	0	0	0	2
MASSACHUSETTS	0	0	2	0	0	0	2
MICHIGAN	0	3	1	0	0	0	4
MINNESOTA	0	0	4	0	0	0	4
MISSISSIPPI	1	0	0	0	0	0	1
MISSOURI	0	0	1	0	1	0	2
MONTANA	0	0	0	0	0	0	0
NEBRASKA	8	1	0	0	0	0	9
NEVADA	0	0	0	0	1	0	1
NEW HAMPSHIRE	0	4	0	0	0	0	4
NEW JERSEY	2	0	0	0	0	0	2
NEW MEXICO	0	2	0	0	0	0	2
NEW YORK	0	2	9	0	1	0	12
NORTH CAROLINA	0	7	0	0	1	0	8
NORTH DAKOTA	0	0	1	0	0	0	1
OHIO	0	4	3	0	1	0	8
OKLAHOMA	2	0	0	0	1	0	3
OREGON	2	0	0	0	0	0	2
PENNSYLVANIA	0	1	7	0	0	0	8
RHODE ISLAND	1	0	0	0	0	0	1
SOUTH CAROLINA	5	0	0	0	0	0	5
SOUTH DAKOTA	1	3	0	0	0	0	4
TENNESSEE	3	0	1	0	1	0	5
TEXAS	0	5	2	0	1	0	8
UTAH	0	3	0	0	2	0	5
VERMONT	0	4	0	0	0	0	4
VIRGINIA	0	0	4	0	0	0	4
WASHINGTON	0	2	0	0	4	0	6
WEST VIRGINIA	2	1	0	0	0	0	3
WISCONSIN	0	1	0	0	2	0	3
WYOMING	0	0	0	0	0	0	0
PUERTO RICO	2	0	0	0	0	0	2
TOTAL	63	64	57	2	19	5	210*

*Includes 6 stations expected to be operational in near-future.

TABLE 2

HOURS PER WEEK OF OPERATION OF STATE ETV SYSTEMS [From Ref. 29]

State Systems Reporting	Hours per Week of Public TV Programs	Hours per Week of In-School Programs	Hours per Week of Other Programs	Total Hours per Week of Operation
Alabama	35	35	0	70
Arkansas	32½	37½	0	70
Connecticut	30	30	6	66
Georgia	48	45½	0	93½
Hawaii	38	25½	7½	71
Indiana	15	70½	0	85½
Iowa	50	35	5	90
Kentucky	22½	45	0	67½
Maine	41	30	8	79
Maryland	60	35	5	100
Minnesota	25	30	4	59
*Mississippi	0	0	0	0
Nebraska	48	32	15	95
New Hampshire	49	25	0	74
*New Jersey	0	0	0	0
New York	39	40	9	88
North Carolina	45	10	3	58
*Ohio	0	0	0	0
Oklahoma	32	35	0	67
Oregon	56	18	0	74
Pennsylvania	45	0	0	45
Rhode Island	32	30	0	62
South Carolina	42	32½	16	90½
South Dakota	63	27	3	93
Tennessee	32	35	0	67
Utah	47	30	0	77
Vermont	5	20	15	40
TOTAL:	932	753½	96½	1782

*Under Construction

TABLE 3

DAYS PER WEEK OF OPERATION BY STATE ETV SYSTEMS

[From Ref. 29]

STATE SYSTEMS REPORTING	5 DAYS PER WEEK	6 DAYS PER WEEK	7 DAYS PER WEEK
Alabama	X		
Arkansas	X		
Connecticut		X	
Georgia			X
Hawaii		X	
Indiana			X
*Iowa			X
Kentucky	X		
Maine		X	
Maryland			X
Minnesota		X	
*Mississippi			X
Nebraska			X
New Hampshire		X	
*New Jersey			X
New York			X
North Carolina		X	
*Ohio			X
Oklahoma		X	
Oregon		X	
Pennsylvania			X
Rhode Island		X	
South Carolina			X
South Dakota			X
Tennessee		X	
Utah		X	
Vermont	X		

*Under Construction

SUMMARY

Total Operating Days Per Week	5 Days	6 Days	7 Days
State ETV Systems	4	11	9

The ETV stations operated by community groups or nonprofit organizations put greater emphasis on public television as opposed to ITV. In the case of ETV stations in Pennsylvania, the entire programming schedule is built around general educational, cultural and entertainment programming for their communities. Some community ETV stations do broadcast ITV programs during weekdays under contract with local boards of education as in the case of university operated ETV stations. Sometimes as much as half of a station's operating budget comes from "participating" school districts in its coverage area, which pay $1.25-2.50 per student per year for instructional programs.

A major milestone in the development of ETV in the United States was the creation of National Educational Television (NET) in 1954 as a service of the National Educational Television and Radio Center (NETRC). At the time of its creation, the center was conceived basically as an "exchange center" for which most of the programming would be produced by the member stations themselves. In its early years, the Center was supported by the Fund for the Advancement in Education (FAE), a creation of the Ford Foundation. However as the years passed by, NET got involved more and more with the production of quality educational programming for the general public. It provided five hours of new NET programming to its affiliates every week, or a total of 260 hours per year. Individual stations also had the opportunity to draw upon NET's vast film and video tape library for additional programming. Prior to 1964, affiliates had to pay an affiliation fee which was based upon the population within a station's coverage area and scaled from a minimum of $7,200 to a maximum of $18,700 annually. In 1964, the affiliation fee was replaced by a token annual membership payment of $100.[26]

In 1963, ETV programming got a new boost when, after a study of the problems and potentialities of ETV, the Ford Foundation (which had taken over the basic support of the Center) announced the first of its annual $6 million grants to finance the program service of NET. At this stage NET turned over to other agencies its previous activities in radio, instructional television, and ETV station activation and welfare. All resources were concentrated on one objective: a television program service of substance and quality, to be provided to the American people through the nationwide network of noncommercial ETV stations affiliated with NET.[30] It was at this stage that NET started becoming referred to as the "fourth network".

John White, former president of NET, has described NET's operation, development and the guiding philosophy in detail elsewhere[30] and it would not be appropriate to dwell upon this subject at length in this memorandum. However, some observations will be made concerning NET's program practices, NET-affiliate relationships and NET's attempts for a live interconnection.

NET devotes at least half of its resources and half of its schedule to programs in public affairs with the intention of inducing people to think critically about public issues, of providing information and instilling a new awareness and desire for more information, and of provoking a new alertness and civic responsibility. The rest of NET's programming--almost half of the total--falls into two categories: cultural programming and programs for children. Detailed discussions on NET programming can be found in an NET booklet[31] published in 1964.

However, it should be noted that not all ETV stations were members of NET. Non-duplication of network service in any coverage area excluded many ETV stations from its membership. Some stations did not become members of NET because their functions were quite different. In addition, there were problems created by NET programming on some hotly controversial issues and the view, held by quite a few people, of NET being run by an elite group of people who were not responsive to the people's real wishes. Some others were afraid of NET turning into a superstructure dominating the American ETV scene. An article by Appy[32] gives an interesting insight into the NET and affiliate relationships which have been described as balanced in station-network acceptance of responsibility with serious imbalances only being short lived.

The idea of live interconnection for ETV stations first took solid shape in August 1966 when the Ford Foundation made its now famous domestic satellite proposal. Ford's proposal called for the creation of a "non-profit satellite system" under the management of a "Broadcaster's Non-Profit Satellite Service Corporation" (BNSC). It had provisions for both commercial and noncommercial television and radio programming. Though nothing materialized in this direction, it stirred up people's imagination and made them aware of the potential desirability for live interconnection of ETV stations. In January 1967, NET began a series of interconnection demonstrations to give the American people some idea of the contribution that national interconnection could make. Since then NET has proved the contribution that live interconnection could make with its coverage of special events, its background analyses of breaking events and its live series on politics, education, science and arts. However, the cost of establishing full-time interconnection was beyond the meager resources of NET and only for a limited amount of time was interconnection of a select few ETV stations achieved. Most of the distribution continued to be accomplished via mail (film or videotape).

Another milestone, and a major one in the development of ETV in the USA, was the creation of a Commission on Educational Television sponsored by the Carnegie Corporation of New York. The Commission was convened to "conduct a broadly conceived study of noncommercial television" and to "focus its attention principally, although not exclusively, on community-owned channels and their services to the general public".[33] The Commission was asked to recommend lines along which noncommercial stations might most usefully develop during the years ahead.

In 1967, the Commission published its report and recommendations[33] which called for immediate action to extend and strengthen educational television, for enlarged federal support for PTV, for continuing study to improve ITV and for Congress to establish a new institution for public television. President Johnson also endorsed the objectives of the Commission. It was here that the word "Public Television" was coined. Soon after, President Johnson sent his proposal for such legislation to the Congress and the Senate. The result was the Public Broadcasting Act of 1967 and the creation of a nonprofit, independent corporation known as the Corporation for Public Broadcasting (CPB). The Corporation was empowered to receive funds from both the government and private sources. The 1967 Act specified CPB's role as being to strengthen local public

broadcasting stations so that they would better serve their communities, to develop an effective national interconnection of these stations (but not to operate this networking system) and to augment the national inventory of programs (but not to produce any programs itself). In addition, it was to provide a number of services such as keeping the public informed of public broadcasting activities.

In slightly over two years, CPB has given a very impressive account of itself. Today, Public Television finds itself on the threshold of greatness from what was supposed to be beyond salvaging at one time. The 1970 annual report of the CPB[17] describes its achievements in developing ETV and extending television's spectrum.

The creation of CPB brought a change in the role of NET. The latter has been turning more and more into an organization primarily involved with the production of quality PTV programming. In the early days of CPB and until very recently, NET managed program distribution and live interconnection (on a limited scale) for CPB because the latter was forbidden from operating a networking system. In November 1969, the Corporation for Public Broadcasting created a new nonprofit, private corporation named the Public Broadcasting Service (PBS) to select, schedule, promote and distribute national programs to the country's noncommercial ETV stations. PBS finally took over the program selection, promotion and distribution responsibility from NET as CPB's independent agent.

Public Broadcasting Service (PBS) is a user-controlled distribution system and is responsible to the stations it serves. It is supported by the Corporation for Public Broadcasting and the Ford Foundation. Its ten member governing board is made up of five representatives from local PTV operations, two public members chosen from outside the industry, and the presidents of CPB, NET and PBS.

Currently PBS is operating an interconnection service feeding some 25 hours/week of programming to its affiliates via AT&T facilities. Some 140 ETV stations are interconnected for live distribution at scheduled times. Currently, PBS and CPB are negotiating an interconnection system with AT&T which will cover all PBS affiliates. Some 109 drop-off points are conceived on AT&T facilities and another 98 on state networks. The main hitch is over the level of the reduced rates that PBS will have to pay. According to one source, AT&T is demanding some $5 million annually to provide this service on a non-preemptive basis whereas CPB and PBS are willing to pay in the neighborhood of $3 million/year.

2.2.3 Regional Networks

In addition to the national PTV network, the Public Broadcasting Service (PBS), there are several regional and state networks that are currently in operation. The regional networks number six; Eastern Educational Network (EEN), Southern Educational Communications Association (SECA), Central Educational Network (CEN), Midwestern Educational Television (MET), Rocky Mountain Public Broadcasting Network (RMPBN), and Western Educational Network (WEN). Table 4 gives a brief summary of the

regional networks--their affiliates, geographical distribution of their affiliates, and the modes of program distribution.

The oldest, most prestigious and perhaps most successful of these is the Eastern Educational Network which was established in December 1960 with the purpose of promoting education by preparing, producing, reproducing, desseminating, furnishing, relaying and otherwise assisting and cooperating with others in broadcasting by television. Among its first members were two ETV stations, community ETV organizations, universities, the State Departments of Education of Connecticut, Rhode Island, and Vermont, the Canadian Broadcasting Corporation (CBC) and NETRC.[34] As of January 1970, EEN had grown to 25 licensee members representing 38 transmission stations in 10 states and the District of Columbia.[35] EEN's library of films and tapes number 891 instructional and 725 public television programs. EEN requires that every member station contribute a certain amount of programming each year, and most of the stations in smaller communities have shared rather extensively in the production chores, apparently attracted by the opportunity to produce one first-rate program and receive many more in return, with their fellow EEN members doing likewise.[35] EEN affiliates have produced programs such as "The French Chef" and Fred Roger's children's program that have been nationwide hits. The distribution within EEN is accomplished by a combination of private microwave, common carrier and bicycling of video tapes.

Midwestern Education Television (MET) was incorporated in 1961 as an effort to facilitate the sharing of educational resources throughout the upper midwest. MET affiliates are interconnected by microwave facilities that they own. A most interesting feature about MET is that its affiliate stations (six in number) pay no "affiliation fee" but are instead paid by MET for carrying MET's programs. As Robertson[35] has pointed out, the one possible limitation in the MET formula appears to be that there are no funds with which to feed on the network programs which cannot "pay for themselves". This would seem to give priority to funded programs over any not funded with the result that viewers might not receive some programs of value because the program does not have any funds to pay its way through.

The Southern Educational Communications Association (SECA) was organized in 1967 to undertake almost any kind of cooperative activity which might prove to be necessary in the field of educational communications. As of January 1970, SECA had 20 licensee members representing 48 transmitters in 11 states making it the largest of all the regional networks. Robertson[35] points out that SECA membership, on the whole, is not so interested in being a "southern bloc" as they are in seeing to it that their views on matters of importance in ETV are heard and acted upon by those in national organizations. Several southern stations do not belong to SECA primarily because they do not wish to associate themselves with what sometimes has appeared to them as a pressure group organized primarily to make special pleadings on behalf of "the South". Other reasons apparently are the lack of enthusiasm for regional split programming in which a series is produced at various stations jointly, and the lack of activity in the instructional programming field. As far as interconnection

is concerned, no inter-state interconnection exists but quite a few states within SECA, notably, Alabama, Georgia, South Carolina, etc. have intra-state networks for program distribution.

The Central Educational Network (CEN) was founded in 1967 to be a midwestern counterpart of EEN. As of January 1970, CEN had 19 licensee members representing 30 transmitters serving 12 states. These affiliates were providing the total finance for the operation of CEN. During the two years of its existence, the CEN tape library has grown to 600 public television programs produced by CEN affiliates, proving that Boston, Philadelphia, New York and San Francisco are not the only markets for ETV production. CEN has no live interconnection facility and the program distribution is strictly via videotape mailing.

In 1969, eight ETV stations in the Rocky Mountain area successfully persuaded the Federation of Rocky Mountain States to help them establish a Rocky Mountain Corporation for Public Broadcasting (RMCPB). RMCPB is essentially a regional counterpart of the national CPB, except that it includes instructional television activities in its scope. The board of RMCPB is made up of two members from each of eight states (Arizona, Colorado, Idaho, New Mexico, Utah, Montana and Wyoming) appointed by their respective Governors. RMCPB has set up the "Rocky Mountain Public Broadcasting Network" (RMPBN) which receives its national feed through a network delay center established in Denver. The Denver delay center performs effectively an almost mandatory function: it makes it possible for all stations to schedule nationally-fed programs at hours when audiences in the Rocky Mountain area are most likely to see them. It also feeds the regional programs of RMPBN to affiliates. The networking is achieved through AT&T facilities.

The Western Educational Network (WEN), established in 1968, is a confederation of 20 stations, three of which also are in the Rocky Mountain Public Broadcasting Network. Other than these three and the ETV station at Las Vegas, all members are located in Washington, Oregon, California and Hawaii. Station KCET serves as a regional delay center for the Pacific Northwest and Southern California. Interconnection is achieved via AT&T facilities for national program distribution and there is not much activity in the area of cooperative programming and program exchange in spite of the fact that among WEN members are KCET (Los Angeles) and KQED (San Francisco)--two of the largest producers of national ETV programs in the country.

One often wonders why these obviously independent and dissimilar ETV stations, already served by a national program service (NET) and by a professional and trade organization (ETS-NAEB), organized themselves into regional groups. Robertson[35] has tried to classify the reasons under two general categories. First, individual stations wanted to improve their programs and second, stations felt a lack of adequate communication with one another and national agencies. Improvement in programs was sought through tape exchanges, joint acquisition and cooperative regional production, through workshops and seminars, through interconnection and multiple station release. Communication was improved by virtue of small group interaction--something not possible at a national level.

Perhaps in the early and mid-sixties when most of these "networks", many of them without any networking, were created, the banding together of stations with common interests gave them a feeling of security as well as a feeling that they could make their views heard to "those people in New York". One must not forget the fact that during the mid-sixties, communication between NET and affiliate stations deteriorated rapidly and station managers felt that NET was becoming more and more unresponsive to them.

However, since 1967 there have been several developments which have affected the role of regional networks. Among these are the creation of the Corporation for Public Broadcasting by the Congress to provide leadership and assistance to stations in a variety of ways, the creation of the Public Broadcasting Service for operating and managing a national interconnection system, and a shift in the role of NET--from a "national network" to that of a prime producer for national television. PBS, which has taken over the program selection, distribution and promotion is a user-controlled group, and the communication problems that had once been a prime force behind establishment of "regionals" will hopefully disappear. This all leads to the question of what should be the role of regionals in view of these new developments. Should they be disbanded should they abandon tape distribution in view of the development of national libraries and improved ETS program service, or should they be given new roles?

Robertson[35], in his study of the "regionals" for CPB, had concluded that: (1) regional organizations in the future will not be able to maintain themselves merely as operators of tape exchange services because of the likelihood that in the near future, PTV programs will be available from a centralized source; (2) joint acquisition of programs and possibly joint purchasing of tape and other essentials, while not adequate reason in itself for maintaining a regional group, holds real possibilities for aid to stations; (3) regional organizations have a very important role to play in encouraging "more than local" production by its member stations; (4) regional organizations seem to be likely agencies through which to handle professional workshops and seminars; (5) PTV interconnection will be a function of the station-managed Public Broadcasting Service (PBS) and will not require regional organizations to implement it; and (6) "regionals" might provide PBS with a workable solution to its station relations problems, while at the same time improving communications between stations and other national organizations such as NIT, NAEB, etc.

2.2.4 Intra-State Networks

At least 15 states have their ETV stations completely interconnected (Table 5) and 6 states are moving towards this goal. Of the 15 states with complete interconnection, nine own the interconnection network and the remaining six use either common carrier or private facilities. Figure 7 shows the location of state and private network interconnection systems.

In January 1971, the Public Broadcasting Service (PBS) conducted a survey of the state ETV network systems, the results of which are tabulated in Table 6. In many states, the network is a multipurpose one--

TABLE 5

INTRA-STATE INTERCONNECTION FACILITIES

STATE	STATE OWNED	COMMON CARRILR	COMBINATION	PRIVATELY OWNED	REMARK
ALABAMA	X				Complete Interconnection
ALASKA					No ETV Stations
ARIZONA					No Interconnection
ARKANSAS					One ETV Station
CALIFORNIA					No Interconnection
COLORADO					One ETV Station
CONNECTICUT				X	Complete Interconnection
DELAWARE					Closed-Circuit ETV Syst.
DISTRICT OF COLUMBIA					Only one ETV Station
FLORIDA					No Interconnection
GEORGIA		X			Complete Interconnection
HAWAII	X				Complete Interconnection
IDAHO					No Interconnection
ILLINOIS		X			Partial Interconnection
INDIANA		X			Partial Interconnection
IOWA					No Interconnection
KANSAS					No Interconnection
KENTUCKY		X			Complete Interconnection
LOUISIANA					Only one ETV Station
MAINE	X				Complete Interconnection
MARYLAND					No Interconnection
MASSACHUSETTS					EEN Interconnection Feed
MICHIGAN		X			Partial Interconnection
MINNESOTA				X	Complete Interconnection
MISSISSIPPI					Only one ETV Station
MISSOURI					No Interconnection
MONTANA					No ETV Station
NEBRASKA		X			Complete Interconnection
NEVADA					No Interconnection (Only one Station)
NEW HAMPSHIRE	X				Complete Interconnection
NEW JERSEY		X			System Under Construction
NEW MEXICO					No Interconnection
NEW YORK		X			Complete Interconnection
NORTH CAROLINA	X				Complete Interconnection
NORTH DAKOTA					Only one ETV Station
OHIO	X				Partial Interconnection
OKLAHOMA	X				Partial Interconnection
OREGON	X				Complete Interconnection
PENNSYLVANIA		X			Complete Interconnection
RHODE ISLAND					Only one ETV Station
SOUTH CAROLINA			X		Complete Interconnection
SOUTH DAKOTA	X				Partial Interconnection
TENNESSEE	X				Partial Interconnection
TEXAS					No Interconnection
UTAH			X		Complete Interconnection
VERMONT	X				Complete Interconnection
VIRGINIA					No Interconnection
WASHINGTON					No Interconnection
WEST VIRGINIA					No Interconnection
WISCONSIN					No Interconnection
WYOMING					No Interconnection

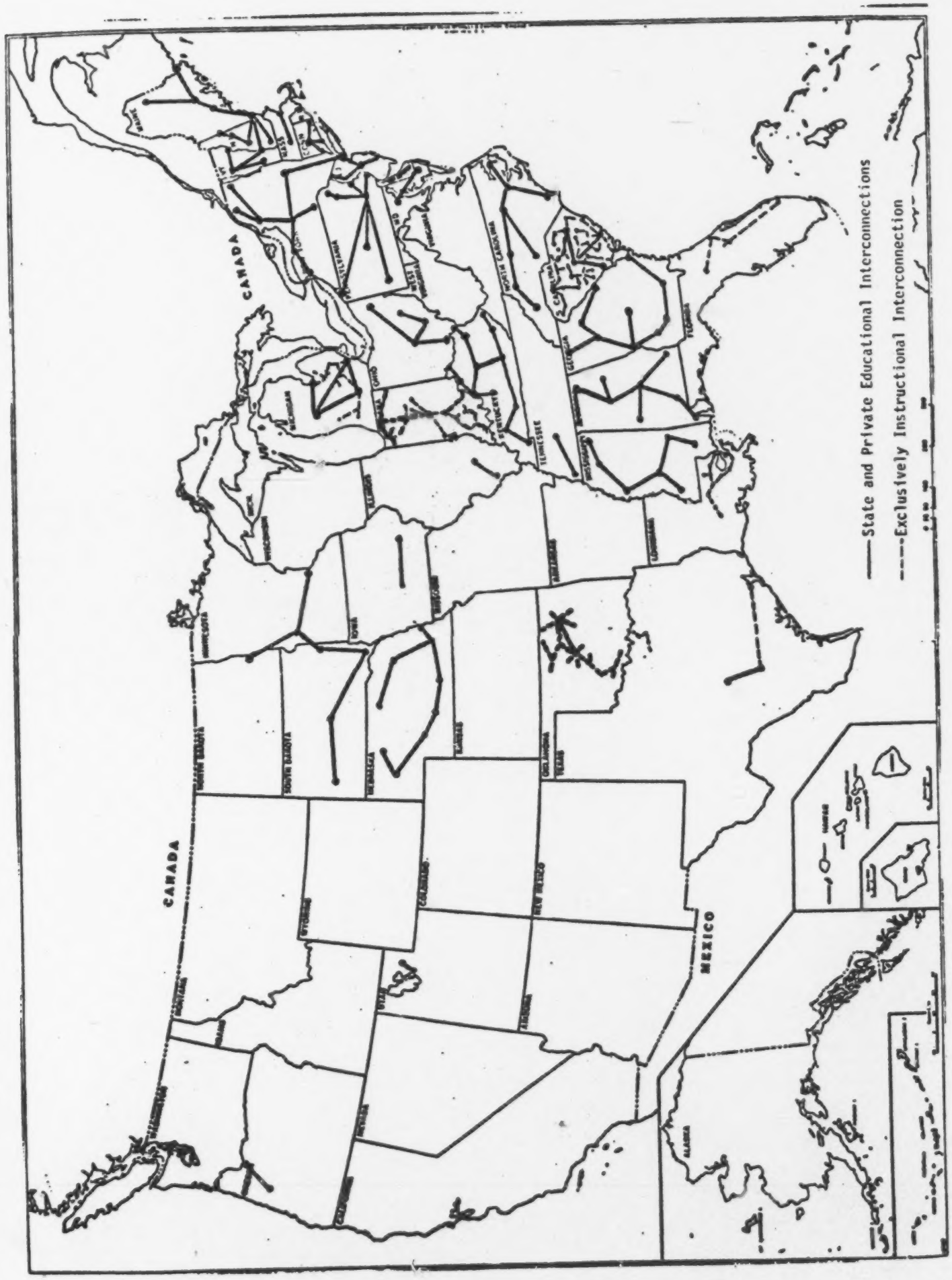


Figure 7

INTER- AND INTRA-STATE EDUCATIONAL COMMUNICATION NETWORKS

TABLE 6

PBS SURVEY OF 15 STATE EDUCATIONAL TELECOMMUNICATIONS NETWORKS

STATE	CHANNEL CAPACITY			USERS SERVED	COVERAGE		
	Number of Video Circuits in Use	One-way or Two-way Channels	Expected Number of Video Circuits by 1975		% of State's population reached by the network	% of the geographic area of the state covered by the network	Changes Expected by 1975
.ABAMA	1	Limited Two-way	2	12 PTV Stations	99%	95%	Very Little
)NNECTICUT	3 (plus 1 remote pickup)	One-way	4 out from Hartford	3 PTV Stations	95%	100%	Increased Power and New Transmitters/Translators
IDIANA	43 (10 Simultaneous Transmissions)	Limited Two-way	44	3 PTV Stations [6 by 1972] 1 High School 16 main and branch university campuses 2 colleges 17 Hospitals 2 CATV Systems	50% of households 80% of Indiana's university and college student population	32%	Increased PTV coverage to 80% of Indiana households and 63% of total geographic area. Increased higher education interconnection; extension of services to elementary and secondary schools.
WA	1	One-way	1	2 PTV Stations	52% [65% by late 1971]	40%	90% Population; 80% area coverage.
NTUCKY	3	Limited Two-way	Not known	13 PTV Stations 4 Universities 5 mental hospitals 1 Community College [2 universities and 3 community colleges will be added in near-future]	100%	100%	100% population; 100% area.
RYLAND	1	Two-way	1 interconnecting 7 PTV stations	2 PTV Stations	60%	50%	100% population and area.
SSISSIPI	1	One-way [Two-way by 1972]	2 two-way channels	8 ETV Stations by end of 1971 5 Universities by 1972 1 ETV station-currently	100% by end of 1971	100% by end of 1971	
BRASKA	1	One-way [Limited two-way by end of 1971; statewide two-way by 1974]	2	9 ETV Stations	98%	98%	No change.
W JERSEY	1	One-way except for a small two-way hop	4 two-way	4 ETV Stations	98%	97% with 80 dbu UHF signal	
W YORK	1	Two-way	Not known	7 ETV Stations 2 State University campuses Griffis AF Base	95%	Not known	
RTH CAROLINA	6	Limited two-way between studios and master control	Not known	5 ETV Stations 3 Campuses of the University of North Carolina	75%	60%	95% of population; 90% of area.
IO	1	Two-way	5 Two-way with drops from five main legs to all 12 ETV stations	2 ETV Stations	50-60%	33%	100% coverage by the end of 1971.
NNSYLVANIA	3 [9 in New System]	1 Two-way [7 in New System]	12	9 ETV stations	96%	97%	Towards 100%.
JTH CAROLINA	11	Two-way	24	5 ETV Stations 218 Schools 17 University campuses 9 Hospitals 32 other institutions	97%	94%	100% coverage.

TABLE 6 (Continued)

STATE	SERVICES OTHER THAN TV SIGNAL DISTRIBUTION		NUMBER OF PROGRAM ORIGINATION POINTS IN THE NETWORK	PROGRAM ORIGINATION		PROGRAMMING HOURS/WEEK	PROGRAM SOURCES
	TODAY	PLANNED FOR 1975		ON TAPE	REAL TIME/ REGIONAL/NATIONAL NETWORK FEED		
ALABAMA	....	Datalinks/ Teletype	7	90%	10%	84 hrs 45 mts	Locally Produced NET, ETS, NIT, MPATI, GPITL, SECA, and PBS.
CONNECTICUT	....	Datalinks/ Teletype	2 [including a remote unit]	90%	10%	....	Locally Produced NET, NIT, EEN AND PBS.
INDIANA	State University Voice Network, Teletype & Data.	Facsimile, Bio-sensing signals, telewriter and instructional radio.	6	79%	21%	123 hrs 15mts	Locally Produced NET, PBS.
IOWA	.....	.....	1	.....	....	.....	Locally Produced NET, ETS, NIT, CEN, and PBS.
KENTUCKY	....	Datalinks/ Teletype	4 [additional 3 in near-future]	50-75%	50-25%	....	Locally Produced NET, ETS, NIT, MPATI, GPITL, SECA, and PBS.
MARYLAND	.....	.....	1	.....	.....	....	Locally Produced NET, ETS, NIT, MPATI, GPITL, EEN and PBS.
MISSISSIPI	....	No firm plans	1	.....	.....	.....	.....
NEBRASKA	Remote Controls: Dataphone	.....	10 [Only one being used]	98-100%	.....	95 hrs	Locally Produced NET, ETS, NIT, GPITL, CEN and PBS.
NEW JERSEY	.....	No firm plans yet	1	.....	.....	.....	.....
NEW YORK	Teletype limited to internetwork communication	.....	9	.....	.....	12 hrs	Locally Produced EEN, NET, PBS.
NORTH CAROLINA	.....	No firm plans	1	.....	.....	.....	Locally Produced NET, ETS, SECA, and PBS.
OHIO	.....	No firm plans	2 [In near-future 10 stations]	100%	.....	30 hrs/week	
PENNSYLVANIA	TWX	TWX, Datalinks	2 [when new interconnection system becomes operational, 7 stations will be able to originate programs]	70%	30%	4.5 hrs/week	Locally Produced NET, EEN, PBS.
SOUTH CAROLINA	.....	No firm plans	1 [+remote facility]	95%	5%	3 hrs/week	Locally Produced NET, ETS, NIT, GPITL, SECA and PBS.

TABLE 6 (Continued)

STATE	TYPE OF OWNERSHIP [OWNED/ LEASED]	IF LEASED,				IF SYSTEM IS OWNED,		IF YOU PLAN FURTHER EXPANSION, WILL YOU LEASE OR OWN
		WITH WHOM IS YOUR AGREEMENT	PERIOD OF LEASE	PAYMENT/YR	DETERRENTS THAT EXIST TO TERMINATION PRIOR TO THE END OF THE LEASE	TOTAL CAPITAL INVESTMENT IN DISTRIBUTION FACILITIES	MODE OF FINANCE	
ALABAMA	OWNED					$3,436,272	State Appropriations and Federal Grants.	OWN
CONNECTICUT	OWNED					$90,000	HEW Grant, State and Private financing.	OWN
INDIANA	LEASED except ITFS systems	Indiana Bell Tel. Co.	month-to-month at lessee's discretion	$699,063	Ten-year decreasing termination liability of $520,000.	$200,000	State Appropriations	LEASE
IOWA	LEASED	Northwestern Bell Tel Co.	10 years-to 1979	$45,000	$21,000 under a 10-yr termination liability			LEASE
KENTUCKY	LEASED	Southwestern Bell Tel Co	30 days terminal notice	$500,000	30 days terminal notice			.....
MARYLAND	LEASED	Chesapeake & Potomac Tel Co	10-yr	$70,000	Financial Penalities			LEASE
MISSISSIPI	LEASED with option to purchase	.....	10-yr with year by year option to purchase	$235,000	.....			LEASE with option to purchase
NEBRASKA	LEASED	Lincoln Tel & Tel Co & Northwestern Bell Tel Co.	10-year terminating June 1974.	$205,000	Obligated to pay full term of lease if terminated early			.....
NEW JERSEY	OWNED					$250,000	1968 Bond issue	STATE-OWNED
NEW YORK	LEASED +OWNED	New York Tel Co	10-year	$365,000	$120,000 reduced by 1/120 for everymonth in operation	$365,000	State Appropriations	.....
NORTH CAROLINA	OWNED					$2,500,000.	State Appropriations	STATE-OWNED
OHIO	OWNED					$169,762	State Appropriations	Not yet decided
PENNSYLVALIA	LEASED	Penna. Bell Tel Co. & NY-Penn -- Microwave Corporation [by Fall 1971]	Regular tariff 10 Yr from October 1971	$564,000 $634,000 [from 10-71]	Proportionate descending termination charges			
SOUTH CAROLINA	LEASED	Southern Bell Tel & Tel Co	Annual Renewal	$1,300,000	None			

TABLE 6 (Continued)

STATE	IF SATELLITE INTERCONNECTION COULD DUPLICATE WHAT YOUR TERRESTRIAL NETWORK CAN DO, WOULD YOU USE IT?	WHAT WOULD BE POTENTIAL ADMINISTRATIVE, OR POLITICAL BARRIERS?	HOW MUCH COST SAVING WOULD YOU HAVE TO INCUR BEFORE SHIFTING TO A SATELLITE DISTRIBUTION SYSTEM?
ALABAMA	Yes	Difficult to determine at this time, but none are foreseeable.	None. As long as no deficit is incurred.
CONNECTICUT	Yes	None.	Present network is state owned. Current cost is basically a maintenance and replacement cost and therefore is very small.
INDIANA	Yes, provided that: IHETS retains the power to specify kind and quality of service at all points; Maintenance and trouble-shooting matches or surpasses quality of present system; Cost are comparable; and that potential for growth and expansion matches or exceeds that of land-based system.	Language of the enabling statute: "to arrange...for the use of a... state-wide telecommunications system furnished by communications common carriers subject to the jurisdiction of the Public Service Commission of Indiana...." Further: "No plans or arrangements for the use of such telecommunication system shall be adopted or entered into... without the specific approval of the governor, the state budget committee and the state budget agency...."	Impossible to state with precision, but any reasonable cost saving would naturally be welcome.
IOWA	Yes	None at present. State board or authority has jurisdiction over noncommercial broadcasting activities in the state.	Very little. As long as the change could be made without disruption or major changes in service.
KENTUCKY	Yes. For national programs.	.....	.....
MARYLAND	Certainly!	The political force of the telephone company.	Unknown.
MISSISSIPPI	Interested.	None, except financing and legal.	Don't know yet.
NEBRASKA	Yes, if it is as reliable, cost is less, and/or if greater services are provided. Would need adjustments to compensate for time-zone changes.	ETV Commission's commitment in Nebraska's consolidated state communications network is major. Would need release of commitment to this effort.	Substantially unless compensated by increased services.
NEW JERSEY	Since New Jersey is building a state-owned microwave system, if present system could be used for backup or for services to additional users, a satellite service may be considered.	None are foreseeable at present time.	Cost savings would have to exceed annual maintenance costs for the present system.
NEW YORK	Yes.	None, if service duplicates current network.	.....
NORTH CAROLINA	Probably.	Depends on who controls access to the satellite.	No idea.
OHIO	It would depend upon the type of interconnection system in use at the time satellite became available.	If the satellite concept could be proved to be more effective or economical, no political or administrative barriers are anticipated to adopting such a system.	Probably a 10-15% savings.
PENNSYLVANIA	Depends on the cost savings. Also, ability to transmit from and to all points in Pennsylvania system is important.	Minimal if statewide access to the system is guaranteed.	Sufficient to offset termination charges and replacement leased auxiliary service charges. Example: Termination charge in 1975 is about $900,000. Auxiliary service runs about $50,000 per year.
SOUTH CAROLINA	Yes.	Nominal.	.....
WEST VIRGINIA	Yes, if state could afford it and if it would allow for local programming to be sent from one part of the state to another.	Whatever would be common to all states making use of a satellite	Cannot say at this point. Though cost savings would be of vital importance, they are secondary to improved services.

TABLE 6 (Continued)

STATE	IF CHANNELS WERE NOT AVAILABLE FOR THE EXCLUSIVE USE OF YOUR STATE NETWORK, COULD YOU FORESEE SHARING ARRANGEMENTS WITH NEIGHBORING STATE NETWORKS?	MINIMALLY, WOULD ANY NATIONAL ITV SERVICE BY SATELLITE BE AN EFFECTIVE SUPPLEMENT TO YOUR NETWORK EVEN IF LOCAL DISTRIBUTION CONTINUED OVER TERRESTRIAL FACILITIES?	WHAT TYPE OF SUPPLEMENTARY PROGRAMMING SERVICES WOULD BE PARTICULARLY USEFUL TO YOU?	REALISTICALLY, HOW MUCH, IF ANYTHING, WOULD YOU PAY FOR AN HOUR OF SUCH PROGRAMMING, IF IT WERE OF EXCELLENT QUALITY?
ALABAMA	YES. Provided National Programs were available for broadcast at a mutually acceptable time.	YES.	Pre-School Civics and Government Current Events and Affairs NOTE: It would be necessary for most ITV programs to follow state adapted courses of study in order to be used on an in-school basis.	Dependent upon need and capability of a local studio to produce the same program $50-100 per hour would be realistic.
CONNECTICUT	YES, if it were for remote pickup on a shared basis. For outgoing programming, we would need four channels for our exclusive use since IDS and local programming for each area will still come from Hartford for the most part.	YES.	Live, on-going coverage of lengthy events such as sessions of Congress and the U.N. General Assembly. On going coverage of "public affairs" or "social studies" programs done specifically for young people.	Not possible to give any estimates. Would depend upon future budgets.
INDIANA	Yes. But administrative, political and tariff barriers might arise. In principle, no objection. Indeed, it would be most advantageous to be linked with neighboring state institutions.	CERTAINLY YES! IHETS is based on the concept of "sharing of educational resources". This concept certainly need not be bounded by state lines.	Access to National Information Data Banks; Seminars in highly specialized areas for professionals; and reports and discussions of new developments and discoveries in any area of knowledge.	Not possible to guess. Would depend upon users.
IOWA	YES, if proper agreements could reached.	YES, probably the major way of distributing ITV programming nationally.	Current Affairs, Special Events. Major instructional projects of a timely nature or cooperative series that cannot be produced on a local basis. Higher education programs with nationwide curriculum acceptance.	Approximately $100/hr.
KENTUCKY	For National Originations.	Absolutely.	ITV - national, e.g., Sesame Street; both as a supplement and "alternative" to teachers in classrooms.	If as described earlier, we could and would, if necessary, pay in the tens of thousands.
MARYLAND	YES.	.....	.....	.....
MISSISSIPI	SURE!	SURE!	Secondary school Instruction	.....
NEBRASKA	COULD SHARE NATIONAL INTERCONNECTION OR COOPERATIVE REGIONAL INTERCONNECTION. IT WOULD NOT BE POSSIBLE TO SHARE STATE ORIENTED PROGRAMMING INTERCONNECTIONS.	YES, if offered expanded services with the possibility for additional regional and state level input.	Additional Program previews Closed Circuit in-house information; Continuing professional education including television skills upgrading.	You've got to be kidding!!!
NEW JERSEY	YES.	ITV service would begin in Fall 1971. It would take several years before schools could be expected to require additional services.	Unknown.	.....
NEW YORK	.....	Supplementary Material is always welcome.	.....	.....
NORTH CAROLINA	IT WOULD BE AWKWARD BUT POSSIBLE.	YES.	ALMOST ANYTHING NOT ALREADY AVAILABLE THROUGH NATIONAL LIBRARIES, AND MUCH OF THAT TOO.	.....
OHIO	WOULD DEPEND UPON THE TYPE OF SHARING. AS LONG AS THE SHARED CHANNEL PROVIDES THE SAME SERVICE(s) OF THE TERRESTRIAL NETWORK IT REPLACES, THERE DOES NOT SEEM TO BE ANY PROBLEM IN SHARING A CHANNEL.	.....	.....	.....
PENNSYLVANIA	QUALIFIED YES, given access assurances and so forth.	If it is supplemental in nature to what is being done via terrestrial facilities.	Special and current events. "Real Time" coverage of events such as UN Sessions, Congressional hearings, debates, Professional meetings, conventions, etc.	$00.00
SOUTH CAROLINA	TO SOME EXTENT; HOWEVER, ADEQUATE FACILITIES MUST BE PROVIDED FOR HIGH NUMBERS OF MULTIPLE CHANNEL TRANSMISSION FOR STATE SYSTEM'S EXCLUSIVE USE.	YES!	IF SUITABLE, ALL TYPES OF ETV PROGRAMMING.	PROGRAM CONTENT AND NEED WOULD DETERMINE THIS FIGURE.
WEST VIRGINIA	MORE THAN LIKELY.	DEFINITELY.	WORLDWIDE CULTURAL AND PUBLIC SERVICE PROGRAMMING.	PROBABLY NO MORE THAN WHAT IS USUALLY CHARGED FOR PROGRAMS FROM LIBRARIES AND

for a variety of uses like instructional TV distribution, medical education and experimentation and PTV program distribution. Of 15 state educational networks that were surveyed, Indiana had 43 TV circuits and was capable of carrying as many as 10 simultaneous TV transmissions over the entire network. South Carolina had 11 video circuits in use. Pennsylvania was planning to extend its capacity to 9 TV circuits from 3 by fall of 1971. North Carolina had 6 TV circuits in use, Connecticut and Kentucky each had 3 video circuits whereas the remaining states had one video circuit. Five of these 15 statewide network facilities were either privately or state owned, one was partially state owned and partially leased from the telephone company, and the remaining nine were leased from the telephone companies. The total annual payment for facilities leased summed up to nearly $4.05 million per year whereas the total capital investment in the state and privately owned interconnection facilities amounted to over $7 million.

2.2.5 Instructional Television

Taylor[36] has well documented the development of instructional television in the U.S. elsewhere. When television caught the imagination of a few innovative educators in the early thirties at a time when the technology itself was not developed fully, educators began experimenting with TV with the primary purpose of using it for instruction. However, it was not until the mid-1940's when television was used for providing credit courses and training. In 1945 the Chicago Public Schools announced that "TV will open startling new methods of instruction" and started using TV as an integral part of their educational program. Programs were broadcast over the commercial TV station WBKB. In the fall of 1946, Ithaca College introduced an ETV course prepared by ABC as part of its regular credit curriculum. One of the first extensive in-school ITV series was inaugurated with one program a week by the Philadelphia Public School System in 1947 in cooperation with WPTZ, WFIL and WCAU. By the early 1950's, the service had increased to thirteen programs a week serving over 60,000 students. Philadelphia schools have continued to be among the leaders in the utilization of ITV. Today, two ETV stations--SUHY, Philadelphia, and WHYY, Wilmington (Delaware)--broadcast forty ITV lessons per week to some 40,000 public, private and diocesan school students in Philadelphia and nearby areas.[37]

As far as TV for college instruction is concerned, in 1950 Western Reserve University pioneered in offering the first broadcast ETV college credit courses in elementary psychology and comparative literature in cooperation with commercial TV Station WEWS. Even with a tuition of sixteen dollars per credit hour for the three-unit courses, 66 persons enrolled and 472 audited the psychology course, and 42 enrolled and 228 audited the literature course.

On the statewide scale, the first ITV project can be credited to the University of Texas which added TV in 1948 to its famous "Radio House". During the 1949-50 school year, "Radio House" broadcast a total of 1,303 program hours through three Austin commercial TV stations and seventy state commercial stations.[38]

In the 1950's and early 60's, commercial networks, particularly NBC and CBS, cooperated with or offered time to educational institutions for ITV programming. Two of the most widely distributed and viewed educational programs were CBS's "Sunrise Semester" and NBC's "Continental Classroom" which were estimated to have served an audience of 300,000. "Sunrise Semester" included courses such as "Introduction to Ethics", "Classical Mythology", "Age of Michelangelo", etc. NBC's "Continental Classroom", which began in the fall of 1968 with a course in physics, included courses in physics, chemistry, contemporary math, American government, etc.

The fund for the Advancement of Education (FAE), a creation of the Ford Foundation, was instrumental in the development of ITV, particularly at the college level. In 1954, FAE introduced TV in classrooms on the college level when it made a grant to Pennsylvania State University to undertake a systematic inquiry into the effectiveness of teaching by TV. The study compared TV with conventional teaching methods and found no significant differences in achievement or attitude. The Pennsylvania State experiment grew to a fully operational system in which, by 1950, some 3,700 of the University's 14,000 students were registered for one or more of the thirteen courses taught over closed circuit on the campus.[39] In 1956, FAE made another grant to the Chicago Board of Education and Station WTTW to undertake a "TV College" curriculum for the Junior College of Chicago. In addition to its successful program leading to an Associate of Arts (A.A.) degree for at-home students, the TV College became involved with teacher training, direct instruction on campus and teaching gifted high school students.[40]

Another major innovation in ITV came in 1959 when the Ford Foundation lent support to Purdue University to investigate the feasibility of transmitting televised lessons from an airborne transmitter, with a potential coverage of five million students in 13,000 schools within the six state region of Illinois, Indiana, Kentucky, Michigan, Ohio, and Wisconsin. In 1959, the FCC granted Purdue University a construction permit to experiment in airborne transmission and instruction on UHF-TV (Channels 72 and 76). The program incorporated as the Midwest Program for Airborne Television Instruction (MPATI), in 1960, became operational on an experimental basis early in 1961. For many years this program operated very successfully but now it has been phased out in part due to the FCC's refusal in 1965 to grant the program regular status and to provide six channels in the UHF band. There was also considerable concern that a permanent airborne system might limit potential local ground-based ETV development[54] and the latter appears to have been the main reason for the denial of the MPATI request. The FCC did grant permission to MPATI in 1966 to conduct an experiment in the 2500 MHz ITFS band for airborne transmission. However, this experiment never got off the ground and the airborne transmission was phased out. MPATI continues to exist as a major program production and distribution center.

At this time, educators interested in teaching by television realized that the anticipated needs of education to fully utilize educational resources and effectively augment the distribution of information to classroom and other services could not be met with the available broadcast channels or via existing broadcast stations. People became more and more interested in closed-circuit television to obtain multi-channel capability.

The now famous Adler Electronics Experiment in Plainedge, Long Island, paved the way for a new class of wireless instructional distribution service which combines the advantages of a relatively economical over-the-air type of transmission on 2500 MHz with multi-channel capability. This distribution system is known today as the Instructional Television Fixed Service (ITFS) and was formally established by the FCC in July 1963 to supplement the educational TV broadcast service. Similar needs for multi-channel delivery capability and specialized applications such as continuing professional education and training, medical education and experimentation, etc. have forced educators and administrators to look at avenues for program dissemination other than broadcast channels. The result has been the inception of specialized microwave networks such as the Texas Educational Microwave Project (TEMP), the Graduate Engineering Education System (GENESYS) of the University of Florida, the Intermedical Television Network in Washington, D. C., and the Stanford University Television System for Graduate Education. In addition, in urban and suburban areas, the growth of cable television offers many interesting possibilities for educational applications, both in terms of diversity of programs and bringing interactive services to enhance learning. The development and the current status of closed-circuit TV, ITFS facilities, specialized networks and cable television (CATV) will be discussed in the following section.

No discussion on the development of ITV in the U.S. would be complete without looking at the regional, state and national production and distribution libraries. In 1961, the McBride study,[41] conducted for the U.S. Office of Education on the use of recorded instructional television materials in the nation's schools, observed that the use of televised instructional series by schools, colleges and universities was increasing and that there was a need to develop distribution systems to facilitate the exchange of these materials. The recommendations made in the McBride report[41] were implemented through the establishment of the National Instructional Television Library (now known as the National Instructional Television Center), the Northeast Regional ITV Library, and the Great Plains National Instructional Television Library (GPNITL).

Until recently, only the GPNITL provided a significantly wide series of tapes. It started in 1962 with one series at the University of Nebraska and today offers more than 100 recorded courses and related teacher utilization and in-service material.[42] Distribution of GPNITL recorded courses is through duplicate video tape recordings made from duplication masters held at the Library in Lincoln. Individual and fresh recordings are made for each user to meet the tape width, scan format and tape speed requirements of his playback equipment. National Instructional Television (NIT) also established in 1962 at the Indiana University, Bloomington, serves a similar function of strengthening education by developing, acquiring and distributing television and other related material for widespread use as major learning resources.[43] NIT has three regional offices at Belmont (Massachusetts), Milwaukee (Wisconsin), and Millbrae (California). NIT comes closest to original plans for a National Program Foundation. The rental fees for ITV program material are based on school enrollment (grades K through 12) and apply to all forms of electronic transmission including open and closed-circuit as well as 2500 MHz ITFS facilities.[44]

In addition to these libraries, MPATI also offers a library of its own instructional material for station use, further adding to the national sources for instructional programming closely related to the activities of the instructional libraries in the National Project for the Improvement of Televised Instruction (established in 1964 through a Ford Foundation grant) sponsored by the National Association of Educational Broadcasters (NAEB). The primary purpose of this project has been the improvement in the quality and the utilization of televised instruction whenever it constitues a significant part of the total program in schools and institutions of higher education.

2.2.6 Discussion

From all these discussions and historical facts, one immediately becomes aware of the absence of any consciousness at the national level about a planned and coordinated growth at the time ETV was created and during its early stages. The sole exception to this comment could be found in the matter of the allocation of channels for the exclusive use of ETV. As Dr. Harry J. Skornia, a pioneer in educational broadcasting puts it:[45]

> "It was created on a shoestring as a last resort to provide education access to these new media of our age which both the FCC and our commercial brethren repeatedly denied us. Of course it was madness, it still is."

Though one may take exception to the latter half of his statement, one can not help agreeing with the fact that ETV has grown primarily due to individual efforts at the local or regional level. The very failure to "unify individual efforts and to weld them into a viable national construct" at its early stages and until recently, has been responsible for the absence of a nationwide ETV network for a long time and led to duplication of effort, time and money which were meager to begin with. However, the PTV segment of the ETV is undergoing a transition since the passage of the Public Broadcasting Act of 1967 which resulted in the establishment of the Corporation for Public Broadcasting (CPB). Within a short time the CPB has considerably raised the image of public broadcasting to what some say as the threshold of greatness[46] from a miserable state which had led some to believe that ETV was very much a lost cause and beyond the point of redemption.[47] One could only hope that a similar action would be taken for instructional broadcasting either by broadening the CPB's charter, by encouraging and supporting other agencies such as National Instructional Television Center (NITC), Children's Television Workshop (CTW), etc. or by setting up an independent agency whose sole mission would be the systematic development and qualitative improvement of ITV and IR.[48]

In addition to this issue, another one that remains to be solved and deserves serious attention is that of providing ETV services to large areas of the country, accounting for some 26% of the nation's population, which do not have access to these services. A major portion of these areas can be identified as Alaska, the Rocky Mountains

and Appalachia.[50,51] All these areas can be characterized as not so affluent, scattered, sparsely populated areas where extremes in topography and/or weather conditions impose severe penalties on ground based telecommunications services.

The improvement of communications in Alaska seems to have a very high priority among state officials. In testimony before the House of Representatives Subcommittee on Space Science and Applications, held on December 16-19, 1969, Senator Mike Gravel from Alaska said, "We in Alaska have inherited the most backward communications system in the nation. Many Alaskans have no access at all to radio or television or telephone."[49]

In 1960, the population of Alaska was 226,167, almost a one hundred percent increase since 1950. By 1969, it had grown to about 270,000.[49] However, even in 1969, only 14 communities out of three hundred in Alaska had populations greater than 1,000. There are two major cities in Alaska: Anchorage (1960 population of 44,237) and Fairbanks (1960 population of 13,311). Of the 1960 population, 140,000,or more than half, was classified as rural. The distribution of settlements is slightly more dense in the southern than the northern part, as one could expect, but the settlements are still evenly distributed over the state.

About fifty thousand Alaskans are Indians, Eskimos and Aleuts. These groups are very poorly integrated into the life of the state although they comprise about one-fifth of the total population. They are also, in the words of one observer, "unspeakable poor, grossly uneducated and politically unsophisticated".[52]

Although there are twenty-six radio stations in Alaska, the service is far from being complete (two of these radio stations are educational). The seven television stations are located in four cities (three in Anchorage, two in Fairbanks, one in Juneau and one in Sitka). Additionally, no programs are received in "real-time" and programs are generally broadcast in Alaska two weeks later than in the lower 48 states because there are no links for overland transmission.

The Rocky Mountain States* are isolated by deserts and mountains. However, while the population of Alaska is evenly sparse (averaging about 0.4 persons/sq. mile), the mountain states population is concentrated in a very few densely populated areas while the rest is almost empty. Average population of the mountain states region is about 8 persons/sq. mile. However, according to the 1960 census, some 40 percent of the population, totalling over 2,874,000, lives in ten Standard Metropolitan Statistical Areas (SMSAs) in the region.** Eliminating that number from tne total regional population yields an average density of about 4.6 persons/sq. mile. This non-metropolitan population is composed extensively of rural population in settlements of less than 1,000 persons. Indian populations range from about 4,000 in Colorado to 56,000 in New Mexico and 83,000 in Arizona. The population of the mountain states is at least as heterogeneous as that of Alaska, ethnically, culturally and economically.

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* Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah and Wyoming.

**Billings, Montana; Great Falls, Montana; Phoenix, Arizona; Tucson, Arizona; Colorado Springs, Denver, Pueblo, Colorado; Salt Lake City, Utah; Provo, Utah; and Ogden, Utah.

There are 12 ETV stations in the Rocky Mountains with two states, Montana and Wyoming, having none. There are some 36 educational radio stations. Of these, six are members of National Public Radio (NPR). The states of Colorado, Idaho, Montana and Wyoming do not have any NPR affiliates. Those TV stations that do exist only provide coverage to SMSA's and neighboring areas. Assuming that each station can serve a population in a 20 mile circle (a highly exaggerated supposition since mountainous terrain severly limits coverage), then about sixty percent of the stations serve a total of roughly two percent of the total land area but nearly fifty percent of the population. However, the 50-55 percent of the people who live spread across the remaining 97-98 percent of the territory have virtually no ETV or ER coverage. Of these remaining 3,645,000 people, about sixty percent are rural, living in areas of 2,500 or fewer inhabitants.

These latter areas are the areas for which alternatives other than conventional radio and TV broadcasting are to be considered. A strong argument can be made that CPB and its instructional counterparts provide necessary coverage to these outlying areas to extend equitable access to educational information dissemination and broadcast services. Such a step could help in slowing migration to already overcrowded metropolitan areas and in strengthening the desirability of living and the quality of life in remote areas for many persons.

2.3 Special Television (STV)

Special Television (STV) was a concept advanced by the EDUSAT study group[53] in response to needs which are neither purely cultural nor instructional in nature. The need for more adequate communication between groups with common interests and information to share has been well known for some time. One could sum up the STV service concept of EDUSAT study as a TV service to meet the information requirements of professional minorities who are increasingly facing obsolescence of their knowledge and practices, e.g. medicine, engineering, teaching, etc.

Currently, limited use is made of ETV for special audiences such as medical groups, law enforcement agencies, colleges and universities, and research and industrial organizations. Most of the efforts are local and have been implemented by either using ITFS or continuing/graduate education networks. No channels are nationally available to cater to all the potential audiences. For some time, the National Library of Medicine has addressed itself to the question of networking ETV stations nationally for a limited time every week to disseminate biomedical information nationally to practicing physicians and medical schools.[55] Unfortunately, in the engineering and teaching professions there is no national agency that has addressed itself to these questions but this does not mean that their needs are less pressing nor that opportunities might not be available for more extensive use of telecommunications.

In this class of service, originally designed for professional minorities, the authors have decided to include services for cultural and ethnic minorities as well, such as Spanish-Americans, American Indians

and migrant workers. The program needs for these "minorities" and their geographical distributions may be quite different. Certain of these groups, e.g. American Indians and migrant workers, do have the following in common--they all are so sparsely distributed that their population within the coverage area of a conventional ground based radio or TV transmitter is not large enough to command any attention. After all, broadcast stations operate on more or less the principle of "common denominator programming". The reason for proposing special programming for cultural and ethnic minority groups is to promote better communication among themselves and with them and to preserve their identity.

The Negro population, which amounts to about 11 percent of the total U.S. population, and a considerably larger percentage in urban core areas, has been able to get special attention from a significant number of ETV stations in the form of their own programs produced by their own people concerning matters that they think are relevant to them, though the sufficiency of the program volume could be questioned. But no other minority, such as Spanish-Americans* or American Indians, has been able to get similar attention. Blame can not be put on PTV stations alone--they have many things to do and that too often on an outlet shared by instructional interests. This issue of diversity of program material poses some interesting questions.

As far as physicians, engineers and a large number of educators are concerned, they live in urban or suburban areas which will soon have multi-channel (12-40 TV channels) CATV systems if they do not have such systems already. For example, there were 272,891 non-federal physicians in the United States as of December 1966.[56] Of these, some 84.5 percent or 230,518 were located in 300 Standard Metropolitan Statistical Areas (SMSAs), areas which have strong potentials for CATV penetration. It is believed that similar or perhaps even stronger would be the case for engineers, university and college educators. However, a major decision-making point comes when one thinks of extending the same coverage to the professionals in small towns, villages and remote areas. Should they be deprived of such a service because they are serving away from urban/suburban centers? This would be contrary to a policy that aims to encourage medical and paramedical people and educators to go to rural, small and remote areas.

The case for providing special service to dispersed cultural and ethnic minorities is also very much the same as that for professionals in remote, rural and small areas--areas which are untouched by cable technology and which, in all probability, would remain untouched due to the lack of an economic support base. These are the cases where the direct reception from a satellite and rebroadcast of satellite signals through relatively low power UHF transmitters needs to be explored.

One of the studies sponsored by the President's Task Force on Communications Policy was "Telecommunications in Urban Development"

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*Two exceptions are the two Spanish-speaking UHF stations in New York City.

by the RAND Corporation.[57] This RAND report dealt competently and rather perceptively with the multiple uses of TV in the "ghetto", very much a minority culture in itself, and suggested some modest experiments on jobs, education, city business, public service, minority culture, and community interaction. Use of low-power TV broadcast stations using locally available management and production talents was suggested. A national program exchange to supplement local productions would be highly beneficial.

Two additional services that the authors have decided to include in "Special Television" category are related to "health delivery", for the general population, and "day care" for children of working parents. With the physician becoming a suburban phenomenon and with the very small number of non-white physicians, the residents of the urban ghetto are, in many instances, unable to receive even minimal medical care. In New York City, for example, about 40 percent of the women who deliver children each year have not seen a doctor during pregnancy.[58] An NAE Committee[59] attributes high infant mortality rates and the relatively poor life expectancy within the United States to the unavailability of medical help for large segments of the population. This situation might be ameliorated by using either automated screening facilities or by operating centers with only paramedical attendants with provisions of access to a large medical center within the city via two-way television. Such an approach of extending some of the services of a sophisticated hospital to outlying rural areas is currently under investigation in Texas and New Mexico. Ohio has recently completed a design study of a microwave TV system for health delivery.[60] Given the will and the resources, there is no reason why the same concept could not be implemented in urban ghettos via CATV facilities. However, extension of the same service to small and rural areas distant from a sophisticated hospital poses a different kind of question and here relatively narrow band radio channels, perhaps satellite based, would have to be used for remote diagnosis.

Another important application of television seems to be in the area of supplementing day-care facilities for pre-school children above 18-19 months of age. Sesame Street has already shown its worth for 3-5 year old pre-schoolers. For a day-care facility, in addition to programs like Sesame Street, one can conceive of programs like "Let Us Play", "Let Us Sing", etc.--programs which require active participation from its viewers. This is an area where BBC educational radio programs of the 60's and 70's can provide some guidelines.

2.4 Closed Circuit Television (CCTV) and Instructional Television Fixed Service (ITFS)

2.4.1 Introduction

Educational telecasters, particularly those concerned with in-school programming, realized quite early in the game the limitation of open-circuit or broadcast TV for delivery of high-volume programming. There were two reasons for this. First, the broadcast spectrum was of insufficient capacity. Second, a broadcast service is essentially a point-to-area service, whereas for much instructional programming, the output is

needed at relatively few points in an area. Furthermore, certain groups were interested in the prevention of unauthorized pickup and use, always a problem with standard broadcast signals. In this section we will describe two services which are designed to overcome this obstacle, namely Closed Circuit Television (CCTV) and Instructional Television Fixed Service (ITFS).

2.4.2 Closed Circuit Television (CCTV)

According to an NEA report[61] on the utilization of in-school CCTV and ITFS, the first CCTV systems were installed in 1954. Educators became so intrigued with the opportunities for innovation and experimentation which CCTV offered that in 1956 they organized a conference on teaching by closed-circuit television.[62] This conference provided educators, then experimenting with CCTV for research as well as to provide credit courses, with a platform to exchange experiences. In the early years of CCTV, the growth rate was much higher at institutions of higher learning than in elementary and secondary schools. However, since 1964, the situation seems to have reversed.[61]

The last available data regarding the number and distribution of CCTV facilities dates back to 1967.[61] Since then, to the best of our knowledge, no new survey of CCTV utilization has been made. Since CCTV installations do not need any registration with a national agency, it is impossible to gather any new information regarding their growth and changes in their utilization without conducting a detailed nationwide survey. In addition, some confusion exists concerning what can be properly labeled as a CCTV system. NEA questionnaires[61] mailed for the 1967 survey defined a CCTV operation as one in which it is not possible for unauthorized TV monitors to intercept and reproduce the program or information being represented. The use of a combination of a portable videotape recorder and/or an accompanying single camera and television monitor sometimes used for observation or magnification purposes is also considered CCTV in the NEA survey.[61]

The NEA survey[61] conducted in 1967 pinpointed 717 educational institutions with closed-circuit television systems. The total number of closed-circuit television installations was 812 indicating that some institutions had more than one operational system. Of these 717 institutions, some 45.4 percent were elementary-secondary school systems, 1.7 percent were nonpublic schools, 7.9 percent were junior colleges, 43.3 percent were institutions of higher education (including medical colleges), and 1.7 percent were other institutions such as seminaries and special training schools.

The type of CCTV installations in educational institutions ran the full gamut from single classroom to state system with 22 percent of all systems being used in conjunction with other systems. Some were linked together by either an ITFS system or a microwave link. Table 7 presents a breakdown of the CCTV installations in terms of their coverage. The majority of the installations were limited to a single room.

TABLE 7 Number of CCTV Installations by Type in 1967[61]

Single Room	Single Building	Local Campus	Local Inter-Connection	State, Regional	Mobile, Portable
472	369	173	41	64	122

The reader is cautioned to view the above classifications rather carefully in making any inferences due to the divergence of the nature and purpose of CCTV systems within a given category. For example, the "Local Campus CCTV" category includes both a three-four channel CCTV facility interconnecting two or three buildings as in the case of an elementary or secondary school, as well as large scale CCTV systems capable of delivering as many as 12 programs to as many as 15-20 widely separated buildings as in the case of Michigan State University. In addition to the wiring, there are also differences due to the usage. The Local Campus CCTV system described for a single school may be used sporadically for supplementing the teacher whereas the Michigan State system, included in the Local Campus Category, may be serving as many as 20,000 students with half of them enrolled in courses taught primarily by TV via the multi-channel system.

Of the 812 CCTV installations reported in the 1967 NEA Survey[61], only 368 reported having at least one Video Tape Recorder (VTR). Some 1087 VTRs were reported to be in use--842 were helical scan, 207 were regular 2" quadratures, and 18 were miscellaneous types. However, since 1967, the use of VTRs in secondary and elementary schools seems to have gone up tremendously. According to recent statistics issued by the National Center for Educational Statistics[63], some 26 percent, i.e. about 21,000 of the nation's 81,000 public schools reported owning VTRs. Twenty-one percent, i.e. some 17,000, reported both VTRs and TV sets. This leads to a feeling that the number of CCTV installations in all educational institutions may have risen very sharply since 1967. After all, the minimum requirement for being counted as a CCTV facility in the NEA survey is a VTR and TV monitor and camera.

From a geographic standpoint, California, Delaware, Illinois, New York, Pennsylvania, and Texas were the largest users of CCTV.[61] As of 1967, the most extensive and sophisticated intra-state CCTV system belongs to Delaware. It consists of a three channel facility linking over 177 school locations and reaching a student population larger than 115,000 students. The system is planned for decentralized program production and allows about 22 stations to insert their locally produced programs into the system.

2.4.3 Instructional Television Fixed Service (ITFS)

Instructional Television Fixed Service (ITFS) is primarily designed for linking closed-circuit TV installations in various schools, separated by wide distances (up to 20 miles) with each other or to a central transmitting station as the need may be. Interconnecting widely separate CCTV installations in various schools by cable, even within a school district, may be an expensive affair. Laying a 20 channel cable costs anywhere between $4,000-$10,000/mile depending upon the local terrain conditions, whereas within a certain interconnection distance, the cost of wireless interconnection by ITFS is fixed for any length and can be less than cable in many situations. For example, interconnection of 20 schools (300 classrooms) with a four channel ITFS system will cost in the neighborhood of $262,000 in capital costs[64] whereas the same interconnection by cable may cost anywhere between $10,000-$1,000,000 depending upon the distances between the central facility and remaining schools.*

The seeds for ITFS were sown in 1961 when the FCC gave permission to the Plainedge Public Schools (Long Island, New York) to experiment in the uncrowded frequency range of 2000 MHz for distributing high quality programs from Plainedge High School to seven other schools. The experiment was highly successful and on July 25, 1963, the FCC opened 31 channels (see Table 8) in the 2500-2690 MHz frequency range for use by educational institutions and organizations. The commission officially designated this service as "Instructional Television Fixed Service" (ITFS) and defined it as follows:[65]

> "A fixed station operated by an educational organization and used primarily for the transmission of visual and aural instructional, cultural, and other types of educational material to one or more fixed receiving locations".

Complete details regarding the purpose and permissible services of ITFS can be found in FCC Rules and Regulations (Vol. III, Part 74, Subpart I) along with requirements for eligibility as a licensee. In brief, the licensee for an ITFS facility has to be an institutional or governmental organization engaged in the formal education of enrolled students or a nonprofit organization formed for the purpose of providing instructional TV material to such institutional or governmental organizations. No numerical limit is placed on the number of stations that may be licensed to a single licensee. However, an applicant is limited to no more than four channels to serve a single area, all of which must be selected from the same channel group. Each channel is 6-MHz wide and AM-VSB modulation is used like in standard broadcast TV.

Although the name of the service suggests that ITFS is limited to the transmission of television signals, nothing in the FCC regulations prohibits the use of audio transmission alone, the introduction of facsimile, or the interconnection of computers and terminals by ITFS. Several ITFS systems now operating television channels contemplate future development of other types of information services.[66] A recent amendment of

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*However, cable can carry as many as 20+ channels.

TABLE 8

FREQUENCY ASSIGNMENT FOR INSTRUCTIONAL TELEVISION FIXED SERVICE (ITFS)

GROUP	CHANNEL NUMBER	BAND LIMIT MHz
A	A - 1 A - 2 A - 3 A - 4	2500 - 2506 2512 - 2518 2524 - 2530 2536 - 2542
B	B - 1 B - 2 B - 3 B - 4	2506 - 2512 2518 - 2524 2530 - 2536 2542 - 2548
C	C - 1 C - 2 C - 3 C - 4	2548 - 2554 2560 - 2566 2572 - 2578 2584 - 2590
D	D - 1 D - 2 D - 3 D - 4	2554 - 2560 2566 - 2572 2578 - 2584 2590 - 2596
E	E - 1 E - 2 E - 3 E - 4	2596 - 2602 2608 - 2614 2620 - 2626 2632 - 2638
F	F - 1 F - 2 F - 3 F - 4	2602 - 2608 2614 - 2620 2626 - 2632 2638 - 2644
G	G - 1 G - 2 G - 3 G - 4	2644 - 2650 2656 - 2662 2668 - 2674 2680 - 2686
H	H - 1 H - 2 H - 3	2650 - 2656 2662 - 2668 2674 - 2680

the FCC rules and regulations governing ITFS may expand and change dramatically the unique character of the system. In its second Report and Order on Docket 18346, effective April 17, 1970, the Commission authorized the use of the 2686-2690 MHz band for response stations "to provide communication by voice and/or data signals" between a fixed station operated at an authorized location and an associated ITFS station. This type of two-way communication system has long been advocated by educators; (several instructional TV systems incorporate the elements of two-way communication, usually by telephone.)

As of September 1970, there were some 157 ITFS systems licensed to various educational institutions/organizations in the U.S. and another 10 were under construction covering a total of 556 channels. Figure 8 shows the geographical distribution of ITFS stations within the U.S. Table 9 gives the ownership and statewide distribution of ITFS stations. Of 157 operational ITFS stations, two are state owned, thirty are owned by universities, six by community organizations, fifty-one by religious organizations, one by a junior college, thirty-eight by school districts and thirty-nine by various counties. The largest group surprisingly belongs to religious organizations which use ITFS for instructional purposes in their parochial school systems. EPIE* Bulletin No. 31[66] presents an interesting survey of 65 licensees operating over 120 ITFS systems. The statistics include origination and relay stations, number of channels, staff, equipment, studies for program origination, amount of local programming, program type and budget. The latter appears to be substantial.

According to Birmingham[67], the fate of ITFS hangs in the balance as the FCC considers two important actions vitally affecting the service. The FCC has put out a notice of proposed rule-making on the regularization of ITFS. This proposal, in Commissioner Rex Lee's words, "affords the educational community a unique opportunity to come forward with solid, positive plans and comments concerning ITFS." "It may," he warns, "be their last chance." The present proposal would compromise with noneducational users by reducing the number of served channels from 31 to 28, i.e. by giving up Group H; nonetheless, it would at least settle the legitimacy of education's claim to these channels.

However, Birmingham[67] seems to be unnecessarily worried over sharing the 2500 MHz band for "educational TV, public TV services, and other educational and noncommercial communications, co-equally for space and terrestrial services."[68] In many instances, sharing is the best way for the efficient utilization of limited but non-depleting frequency resources. Positive conclusions regarding possible sharing of wide-band TV transmissions from space and strong VSB-AM ITFS signals have already been reached.[69]

ITFS has indeed suffered from two things: (1) FCC authorization of reservations in the 2500-2690 MHz band for ITFS without firm foundations on which to evaluate either the technical capability of the system or the ultimate needs of education for this service; and (2) the stereotype

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*Educational Products Information Exchange.

TABLE 9

OWNERSHIP AND DISTRIBUTION OF ITFS SYSTEMS

STATE	STATE OWNED	UNIVERSITY OWNED	COMMUNITY OWNED	RELIGIOUS ORGANIZATION OWNED	JUNIOR COLLEGE OWNED	SCHOOL DIST. OWNED	COUNTY OWNED	TOTAL
ALABAMA	0	1	0	0	0	4	4	9
(Applied For)	0	0	0	0	0	0	2	(2)*
CALIFORNIA	0	7	0	7	1	6	5	26
(Applied For)	0	0	0	0	0	0	2	(2)*
DISTRICT OF COLUMBIA	0	0	0	1	0	0	0	1
FLORIDA	0	0	0	8	0	0	8	16
(Applied For)	0	0	0	0	0	0	1	(1)*
GEORGIA	0	1**	0	0	0	0	0	1
ILLINOIS	0	3	0	0	0	3	0	6
INDIANA	0	2	1#	0	0	0	0	3
KENTUCKY	0	0	0	0	0	2	0	2
LOUISIANA	2	0	0	0	0	0	0	2
MAINE	0	2	0	0	0	0	0	2
MASSACHUSETTS	0	1	0	6	0	0	0	7
(Applied For)	0	1	0	0	0	0	0	(1)*
MICHIGAN	0	1	0	1	0	1	1	4
MINNESOTA	0	0	0	0	0	1	0	1
MISSOURI	0	1	0	0	0	0	0	1
NEBRASKA	0	0	0	0	0	2	0	2
NEVADA	0	0	0	0	0	0	1	1
NEW YORK	0	1	0	16	0	7	0	24
NORTH CAROLINA	0	2	0	0	0	0	1	3
OHIO	0	1	2	5	0	0	1	9
(Applied For)	0	0	0	0	0	1	0	(1)*
OKLAHOMA	0	0	0	0	0	0	0	0
(Applied For)	0	1	0	0	0	0	0	(1)*
OREGON	0	0	0	0	0	0	5	5
PENNSYLVANIA	0	2	0	0	0	5	2	9
(Applied For)	0	0	0	0	0	1	0	(1)*
TENNESSEE	0	0	0	0	0	0	6	6
TEXAS	0	1	2	0	0	4	0	7
UTAH	0	0	0	0	0	0	0	0
(Applied For)	0	1	0	0	0	0	0	(1)*
WISCONSIN	0	1	1	7	0	1	0	10
TOTAL	2	30	6	51	1	38	39	157
(Applied For)								(10)*

*Applied For
**Licensed to Fulton-DeKalb Hospital Authority (Working in cooperation with Emory University)
#Licensed to Midwest Airborne TV Instruction Program, Inc. for Airborne Transmissions.
Not in use.

NOTE: States ALASKA, ARIZONA, ARKANSAS, COLORADO, CONNECTICUT, DELAWARE, HAWAII, IDAHO, IOWA, KANSAS, MISSISSIPPI, MONTANA, NEW HAMPSHIRE, NEW JERSEY, NEW MEXICO, NORTH DAKOTA, RHODE ISLAND, SOUTH CAROLINA, SOUTH DAKOTA, VERMONT, VIRGINIA, WASHINGTON, AND WEST VIRGINIA DO NOT HAVE ANY ITFS INSTALLATIONS.

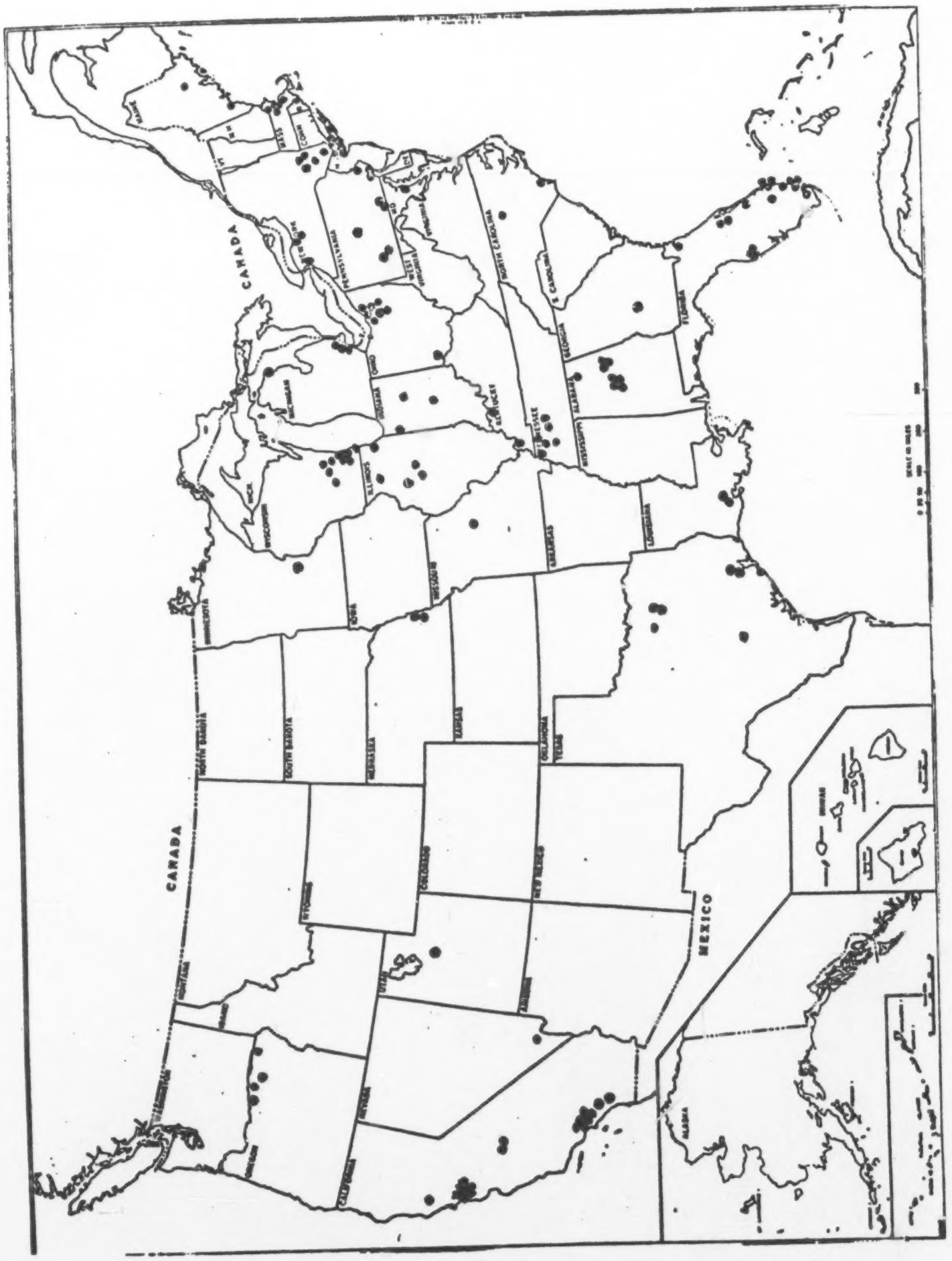

Figure 8
DISTRIBUTION OF ITFS INSTALLATIONS

conception of ITV based on the traditional broadcast type image that has inhibited full development of ITFS for experimentation with the medium of television. With notable exceptions, ITFS has been used primarily for the distribution of existing or traditional program material; its use has been more or less limited to traditional classroom situations and ITFS distribution has been restricted to instructional TV material, with very little application of the medium for computer-communications, data transmission, and educational administration.

2.4.4 Closed-Circuit (CCTV/ITFS) Networks

Since the late 1960's, a large number of instructional networks have come into being, primarily for the continuing education of working engineers with the intent of "updating" as well as "upgrading" their education and for quick access to the centralized files and training skills and techniques for hospital personnel. No discussion of closed-circuit and ITFS systems would be complete without looking at these "networks" which are comprised of closed-circuit, ITFS as well as common carrier facilities.

The first such "network" to be organized was the Graduate Engineering Education System (GENESYS). It was established by the University of Florida in 1964 to meet the continuing education need of employed engineers at eight different locations some 350 miles apart.[70] Currently some 44 courses per quarter are offered and there are plans to double this number. Similar facilities, inter- as well as intra-university, exist at a number of universities. Most prominent among these are Michigan Expanded Resource for Graduate Education (MERGE) at the University of Michigan,[71] The University of Texas ETV microwave relay system linking some 14 locations including six universities and four colleges, the TAGER system of North Texas and the Stanford Instructional Television Network.

The TAGER system is perhaps the first joint venture on the part of the industry and the educational establishment to allow participation of industrial employees in graduate and other programs right on the employer's premises with minimum loss of working time and without any major disruption of the day's activities. It is essentially a closed-circuit system using live interconnection in the 12.2-12.7 GHz business radio band. The Stanford System[72] is very much based on the TAGER model except for the fact that it is essentially a one university effort. The system is capable of televising some 180 three-unit courses during a calendar year representing more than 5000 hours of academic lectures every year. Program distribution is made via a four-channel ITFS system with a 12-GHz studio-to-transmitter link (STL) connecting the origination points in the university to the transmitter located on a hill-top.

It is conceivable that at some time in the not-too-distant future these inter- as well as intra-university networks may wish to have access to each other's resources and some sharing provisions may develop because in higher education there is considerable conformity among various curricula.

2.5 CATV and Educational Television and Radio

Community Antenna Television (CATV) has its roots in the late 1940's and early 1950's, a time when TV broadcasting was still very much in its infancy and the few TV stations that were operating were mainly in metropolitan areas. The first CATV system is credited to Astoria, Oregon where in 1949 one L. E. Parsons "went searching all over the Clatsop County, Oregon" with signal-survey equipment for signals of television station KRSC-TV, 125 miles away in Seattle. The "search" was in response to his wife's request for "pictures with radio". Parsons finally settled on the top of his own apartment building and developed a "watchable" service which he later on extended to a hotel lobby and a nearby music store with the help of a home-made three-tube distribution amplifier. Soon, other locations were attached to Parson's installation at a cost of $100 per connection and the nation's first CATV system was born.[73]

In 1950, the number of CATV installations in the country was only five, but by 1953, there were almost 300 systems--concentrated in the Appalachian mountains and Pacific Northwest. Almost all systems were designed to bring distant TV signals to areas which did not have any coverage. However, in the late 50's, the trend began to change. By 1958, there were more than 700 cable systems--still concentrated in mountain country, but now also extending into wide, sparsely settled plains areas of Texas. A few CATV systems were operating in towns where a single TV station already existed but most people were willing to pay a fee for a service that added program diversity.

Today, nearly 21 years after the first CATV system was born, the number of CATV systems have grown to over 2400 serving more than 5 million TV households out of a total of nearly 62 million. Figure 9 presents the growth rate of CATV since 1956 in terms of TV households served whereas Figure 10 shows the growth of operating systems. This all has been accomplished in the face of massive resistance forces. It would be out of place to say anything in detail regarding the development of CATV, FCC's regulations on CATV, and the opposition put up by various factions who think that the growth of CATV would harm their interests. However, interested readers are referred to papers by Smith[75], Barnett[76], and Legg & Company[78] for detailed discussions on these matters. A recent publication by the National Cable Television Association (NCTA) also illustrates some of the issues in the area of regulation and copyright.[77]

The service, that originated solely for the purpose of providing access to distant TV channels in order to obtain greater TV program diversity and improved reception, has evolved today into a new concept of "wired city"[79] alias Integrated Urban Communication System,[80] alias "Broadband Communications Network".[82] Today CATV has become an accepted means for providing a much larger quantity of radio and television programming than is possible with broadcast TV and radio due to the limited availability of the frequency spectrum for the latter service. Since program distribution is made through a cable, a "non-radiating" medium, all the allocated TV channels could be used locally and the same channels could be used any number of times through the use of multiple cables.

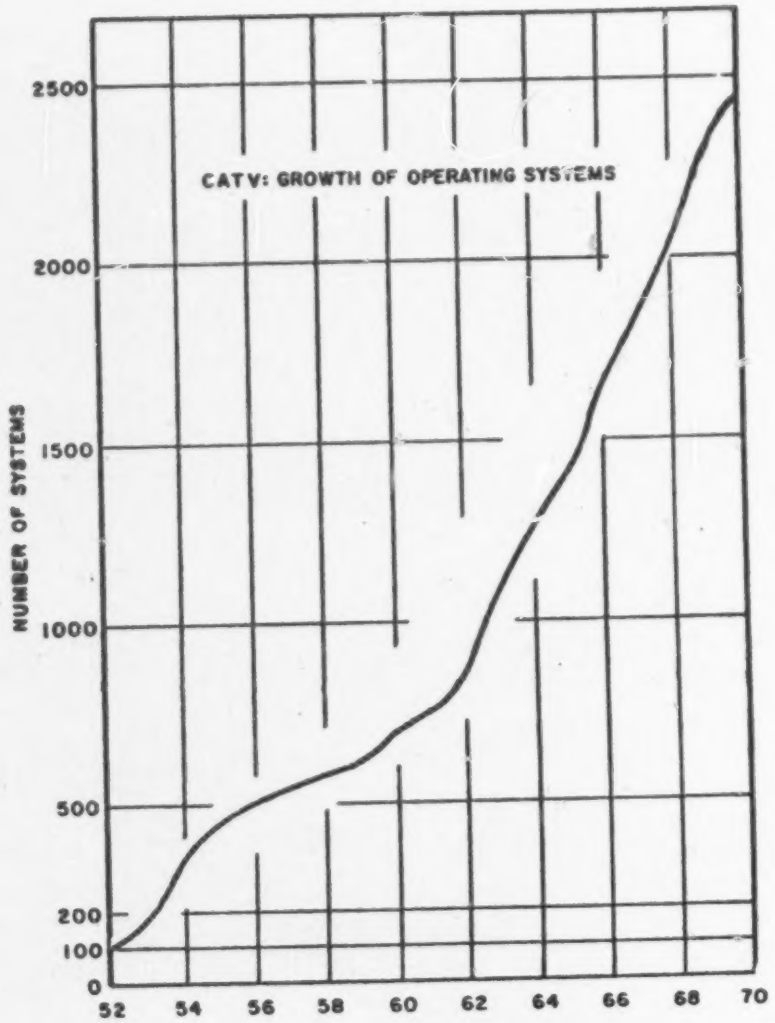

Figure 10. Growth of CATV Operating Systems [Ref. 111]

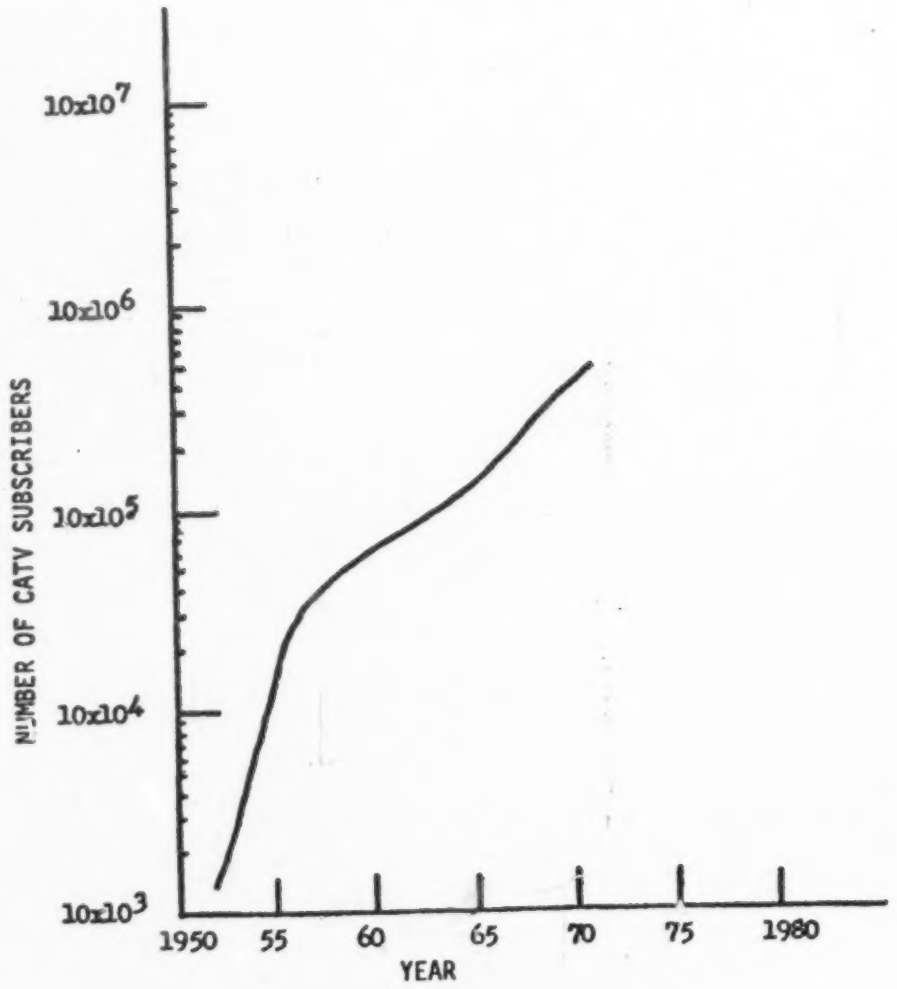

Figure 9. Growth of CATV Households [Ref. 111]

CATV systems[83], which allow individual home terminals connection with the program "exchange" through an individual cable or line, offer a greater potential for virtually unlimited program selection than the standard AM-VSB/FDM* cable distribution--the constraint being what is available for delivery and not the delivery system itself. In addition to the improved delivery of a greater quantity and choice of radio and TV programs, today system designers are thinking about a variety of other services that a cable network could handle. What started as Community Antenna Television (CATV) or Cable Television (CTV) has grown to a point where the terms CATV or CTV fail to do justice to the potential of the communication medium. "Integrated Urban Communication System" (IUCS) or "Broadband Communications Network" (BCN) are more suitable terms to describe the medium. Table 9 shows some of the potential CATV or wired city services.

A cable television system may serve the educational needs of its community in any of the following ways:[84]

(i) Carrying the signals of one or more educational stations to citizens of the community (if the ETV station happens to be a local one, a cable system is required to carry it under the FCC regulations).

(ii) Providing connections and multiple outlets to local schools, enabling the teachers to make use of educational and commercial programs in the classroom.

(iii) Providing a channel through which educational programming originated by a local school or educational agency may be distributed to the entire school system and its community.

To date, the primary interrelationships between the cable systems and educators have come about because CATV systems carry broadcast ETV signals. According to 1966 statistics, of 719 CATV systems located in 45 states which received the signals of 94 ETV stations located in 36 states and the District of Columbia, 641 were carrying 1 ETV signal, 72 were carrying 2 ETV signals, 5 carried 3 ETV signals and 1 system carried 4 ETV signals.[85] However, the FCC ruling that all cable systems having more than 3500 subscribers must originate programming "to a significant extent" by April 1, 1971 may very well lead to some new and exciting relationships between CATV systems and educators.** This means that cablecasters would have to have local production facilities and some programming expertise.

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* Amplitude Modulated Vestigial Sideband Video/Frequency Division Multiplexing.

**This has not completely materialized to date due to a successful court challenge in St. Louis.

TABLE 10

POTENTIAL CATV/ WIRED CITY/ BROADBAND COMMUNICATION SYSTEM SERVICES

HOUSEHOLD	BUSINESS	SCHOOLS	GENERAL PUBLIC
POLICE, FIRE AND MEDICAL HELP SIGNALS	CCTV	CCTV	TRAFFIC SURVEILLANCE
TELEMETERING - GAS, WATER AND ELECTRICITY METER	DATA RETRIEVAL	PUBLIC RADIO & TV	TRAFFIC SIGNAL CONTROL
BANKING	COMPUTER TIME-SHARING	COMPUTER TIME-SHARING	FIRE AND CRIME SURVEILLANCE
ELECTRONIC MAIL	FACSIMILE MAIL AND NEWS	COMPUTER BASED INSTRUCTION	POLLUTION SURVEILLANCE
CONSUMER INQUIRY	DATA TRANSMISSION	DATA RETRIEVAL	
SHOPPING	CONTINUOUS BUSINESS NEWS - STOCK MARKET SITUATION ETC.	INFORMATION RETRIEVAL TV	
CONTINUOUS NEWS, WEATHER AND BUSINESS INFO.	CUSTOMER SALES	IMPLEMENTATION OF AN EDUCATIONAL INFORMATION SYSTEM (EIS) FOR IMPROVED EDUCATIONAL MANAGEMENT	
FACSIMILE NEWSPAPERS	TELEMETERING		
PAY TELEVISION	POLICE AND FIRE SIGNALS		
LARGE NUMBER OF TV AND RADIO PROGRAMS			

Because a great many educational institutions possess closed-circuit TV facilities (a minimum of a video tape recorder and a camera) Schwartz and Woods[86] suggest that they can prove to be a marketable asset to assist in resolving the cablecasters' dilemma or in fulfilling the cablecasters' desire to provide local originations at a very small fraction of commercial TV costs. A recent report by Feldman[87] of RAND Corporation examines the local origination issue in detail and suggests several types of programs that could be locally originated at reasonable costs. There is no reason why local educational institutions and students can not be involved in their production. A recent article[88] does suggest that some cable systems are moving in this direction.

In most states anyone wishing to operate a CATV system must approach the officials of the city, town or village in which he wishes to operate. A CATV franchise is then negotiated after a public hearing on the matter has been conducted. Educators have started taking quite an active part in these hearings to insure that the franchise offered to the operator defines the ETV-CATV relationship. In Long Island (New York), SCOPE, a regional educational service center has pioneered in the area of monitoring CATV developments in the areas covered by its member school districts and in writing educational provisos into CATV franchises.[84] The following are some of the important offerings that SCOPE members have been able to extract from CATV systems:

(1) CATV operator installs without charge into each school building, private and public, college and library, receiving terminal and cable connections to enable each building to receive all programs transmitted and distributed over the CATV system.

(2) Allocation of at least one video-audio channel, without charge, for educational use. Channel to be used primarily for transmission of locally originated educational programming to home.

(3) CATV operator providing for school use a video tape recorder so that school authorities can provide the operator prerecorded video tape programs for transmission, without charge, at the requested time and dates.

(4) CATV operator agrees to provide reception and distribution of one ITFS channel during first five years of franchise if a school district constructs an ITFS system. CATV operator has to bear the cost of down-converting the ITFS channel to VHF midband (between Standard TV channels 6-7) and at school buildings again up-or down-converting them to VHF and/or UHF channels.

(5) CATV operator agrees that after first ten years of his franchise, he will provide, without charge, to each school district in its coverage area a CATV channel which will inter-connect the school district media center and school media centers of each school district within the system franchise area, and the educational channel of the local CATV system and the educational channel of CATV systems in adjacent towns.

(6) CATV operator agrees that after he has held his franchise for ten years, he will, without charge, provide a TV studio to school districts for up to 50 percent of operating time or at least 20 hours/week (inclusive of technical operating and graphics personnel).

SCOPE (Suffolk Educational Center) has been circulating a "model" franchise based on the above-mentioned services to all educators who are interested in seeing that CATV franchises specifically spell out ETV-CATV relationships. According to one source, the benefits mentioned above are estimated worth $200,000 to $250,000 annually[90] and may seem to be rather expensive, particularly on small CATV operators serving in the neighborhood of 3,500-10,000 homes, their main revenue source being a $4-7 monthly charge. It is beyond the scope of this memorandum to say what "benefits" are appropriate and what are not. They have been mentioned to make readers of this memorandum aware of the relationships between ETV-CATV and the thinking of educators interested in educational telecommunications.[101]

In addition to these benefits, the FCC disclosed a "Public Dividend Plan" sometime ago that it is considering in view of its pending decision on CATV regulation and copyright issues. Under this plan, in addition to a copyright royalty payment, which presumably will be made by all CATV systems, the FCC proposes to impose a fee (5% of gross revenues from subscriptions) on CATV systems, in the top 100 markets only, to be payed to the Corporation for Public Broadcasting.[77] However, none of the two studies made recently by the FCC staff endorse this idea, and instead a separate internal FCC document is said to have recommended this fee to be given to local groups for programming.[91]

One thing that becomes evident from the above discussion is that what ever path the FCC decides to take in the matter of the regulation and copyright, educational TV and radio have a lot to gain from CATV. However, much of these benefits would also depend on the growth of CATV and its ultimate penetration. Figure 11 shows Taylor's[74] estimates for the CATV penetration in terms of TV households reached. This estimate has been described as "pessimistic" by some because the critics say that it represents an average growth rate of 14.2 percent for an industry that has been experiencing growth at rates of 25-40 percent. Penwell[106] of National Cable Television Association thinks that a 60 percent penetration of TV households is possible within the next ten years provided the FCC relieves its interdiction on the carriage of distant signals into major markets, low-cost programming sources such as CBS-EVR are available, and that a direct satellite-to-CATV headend interconnection is allowed.

In a recently published RAND report[107], Park has estimated an ultimate penetration of 40 to 45 percent of TV households nationally which does indicate Taylor's[74] estimates being rather pessimistic. Park's[107] analysis is based on the logistic growth curve and a measure of "attractiveness" defined in terms of the missing network signals, the distant signals and the local carriage. What makes one suspicious of Park's[107] estimates also being on the lower side is that nowhere has he accounted for increased "attractiveness" due to various kinds of services CATV-BCN would bring to people--households and business both--services which are currently non-existant.

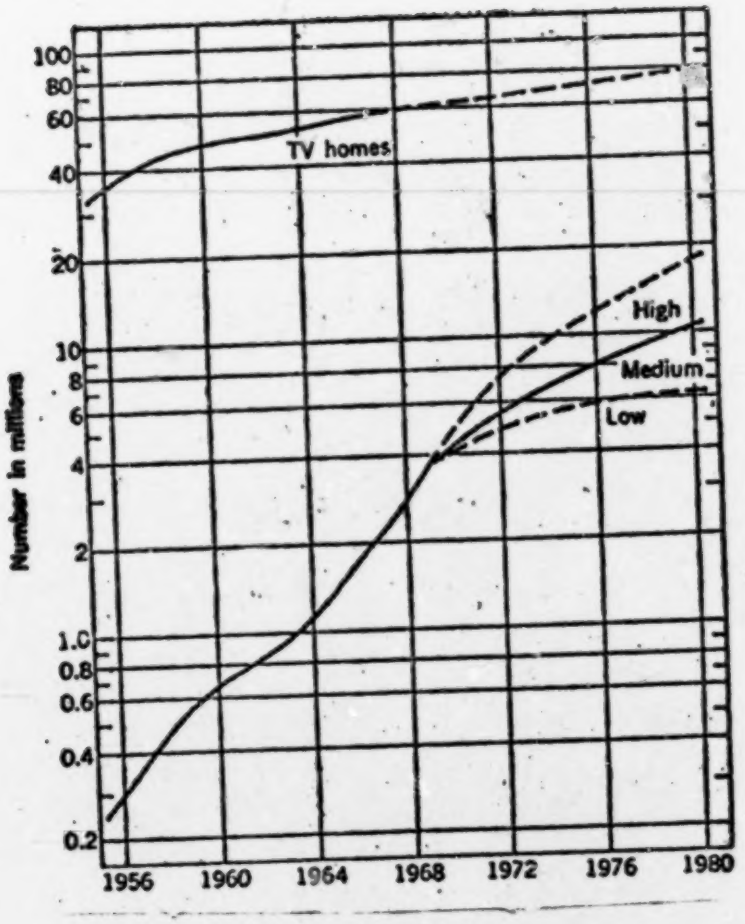

Figure 11. Projected Growth of CATV
[From Ref. 74]

Figure 12 presents one projection for CATV geographic service areas for 1975.[108] One must remember that the cost to provide CATV to 50 percent of households is quoted as $11 billion but it rises to $66 billion for 100 percent saturation.[93] This 400 percent increase in the cost for covering half of the nation's households acts as a deterrent to CATV penetration in these areas.

Another thing of interest to educators is the interconnection of CATV headends by a domestic satellite facility. Many of the domestic satellite proposals (see Appendix B) have expressed strong interest in this interconnection. One by Hughes Aircraft Company has come out with the proposal of providing a program package for the CATV industry which would include a segment devoted to educational aspects and selected by an advisory committee. In addition, a potentially important benefit would arise if and when, at an appropriate time, the Corporation for Public Broadcasting decided to start a second PTV service because CPB could readily use the available satellite-to-CATV headend interconnection. One must note that according to the FCC TV channel assignment plan[94], the second ETV broadcast service could be provided at very few locations as no second ETV assignments have been made for a large number of areas. The CATV-satellite combination offers a potential solution for a second ETV service.

2.6 Information Retrieval/Dial Access Television

Information Retrieval Television (IRTV) is the name used to describe a television system that serves multiple users according to their demand. Users get access to the central facility and depending upon their position in the "queue" receive the program of their choice. When the request for the program is made by a phone, the television system is a simple information retrieval system but when a "dial" is added for the direct lodging of the request with the central library, the system is called a "dial access" system.

One of the most talked about IRTV systems is in Ottawa (Canada). It is an experimental system sponsored by Bell Canada, Northern Electric Laboratories, the Ontario Institute for Studies in Education and the Ottawa Board of Education. The system links classrooms in four schools with a central library containing 2500 films and video tapes and a transmission center equipped with telecine units and video tape reproducers. Classrooms are linked to this central library with a coaxial cable capable of carrying 12 simultaneous programs.[95] To use the system, a teacher selects a program from the library catalogue, phones the library from the classroom telephone and books the program for the time it is required. If the time slot is not available, an alternative time is offered. Bookings may be made on an on-demand basis or in advance. In the case of on-demand bookings, the program is transmitted to the classroom in less than two minutes.

However, a look at the literature[96,97] suggests that the information retrieval TV concept was first implemented in the U.S. The first dial-access type IRTV systems to become operational were in Beverly Hills, California and in Evanston, Illinois. Both of these systems

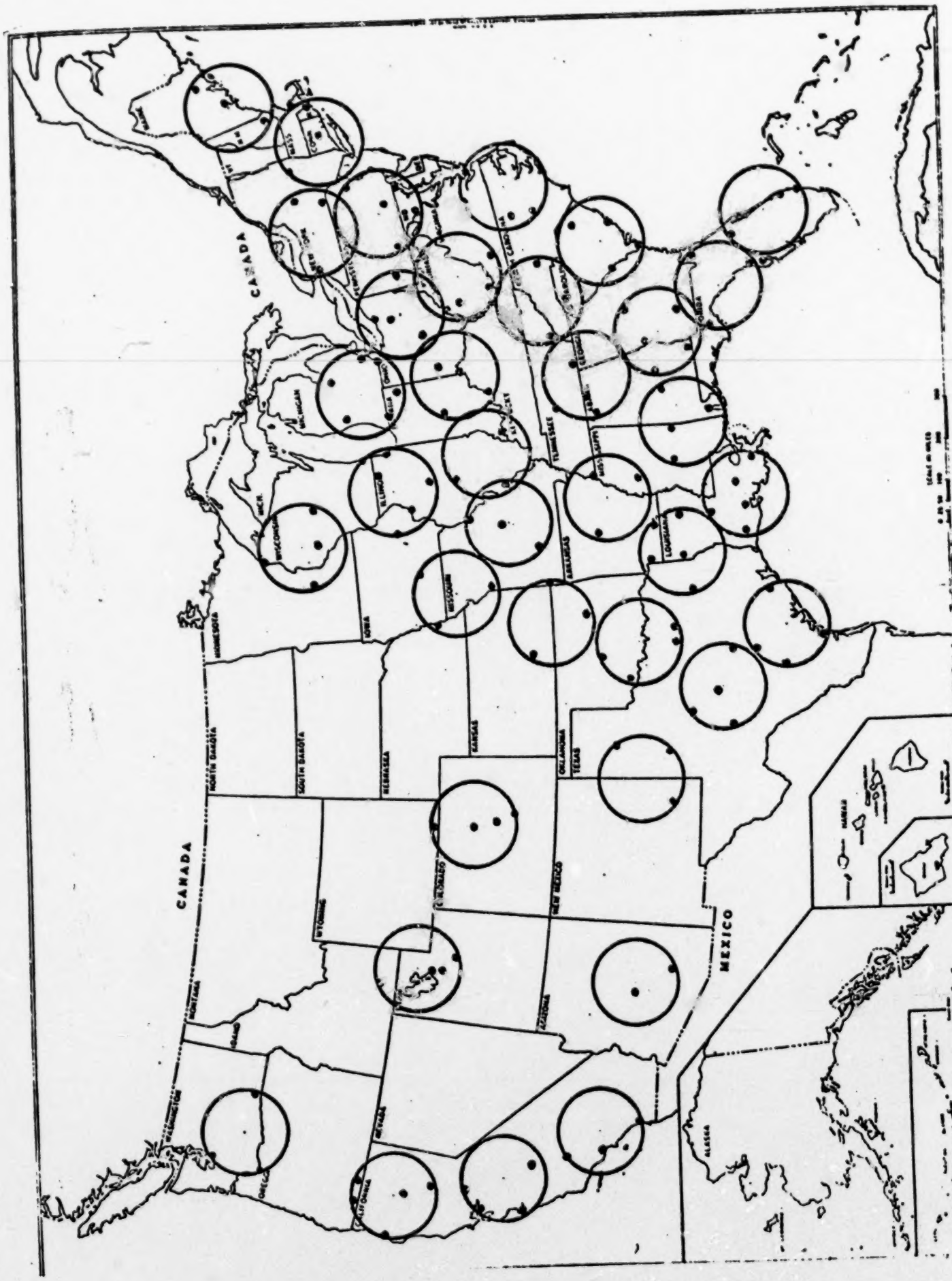

Figure 12. PROJECTED CATV SERVICE AREAS IN 1975 [From Ref. 108]

were funded under the Elementary and Secondary Education Act (ESEA) Title III of 1965. Evaluation of the Beverly Hills system was published in the June, 1970 issue of Educational Television.[96] The main problems seem to be (1) how you implement a dial-access system for a large number of users, (2) what should be delivered and (3) who has priority? Delivering wideband signals on a demand-access basis to a large number of viewers is a very costly business and the planner has to devise schemes of putting those programs on the dial-access system which can not be tolerated on a hard-scheduled system.

The problem of "how to deliver" also seems to rest with the design of the distribution system (coaxial cables or HF twin pairs). Ordinarily twenty TV channels are stacked together using Frequency Division Multiplexing on a single cable. The dial-access TV system developed by the Rediffusion in U.K.[83] seems to be a more suitable choice for implementing dial-access TV systems as opposed to using coaxial cables. Unfortunately, the Rediffusion dial-access system has not caught on in the U.S.*

Today there are only a handful of dial-access systems in the U.S. From their very nature, these systems are primarily local, or at most regional. It is believed that the long-distance telecommunications cost of giving thousands of students access to a distant central station simultaneously for receiving independent TV programs may prove to be prohibitive. In all probability, dial-access systems would be implemented on a local basis--a central library serving nearby schools through individualized terminals. The role of long-distance telecommunications will be limited to the distribution of program material to these local centers. Local centers would generally store program material that would be used heavily, and would be able to obtain special programs from a regional or national library if someone desires.

2.7 Responsive Television (RTV)

Responsive TV is a unique system designed to convert videotaped or broadcast programs into an active-participant involved medium. It allows the viewer to interact with the program in a fashion similar to that found in film-strip and phono-teaching machines.[98] The system allows the interruption of the program story and an opportunity for the viewer to select one of several "story" alternatives. Responsive television has the virtue of being compatible with all existing television program origination and dissemination systems, including broadcast TV, CATV, Video Tape Recorders and Electronic Video Recorder/Cartavision. The viewer response is processed locally and does not have to be transmitted back to the program source.

The responsive TV system consists of a response unit (a small keyboard device) attachable to any TV monitor (color or black/white) and a video source. The response unit has four rows of push buttons with four buttons in each row. Only one button can be depressed in each row. When a second button is depressed in a row, all other buttons in that

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*One such system is under development at Dennis Port, Massachusetts.

row are released. These buttons, which are designed to "unblank" a particular portion of the TV screen, allow "screen-splits" and "branching".

At each step of learning, the announcer on the television screen might ask questions to test the viewers' comprehension of the materials just covered, directing them to press one of the response buttons to indicate their answers. The viewers would then be given time to make their choices, each learning individually (even though at different receiver locations) whether he is correct or incorrect, receiving further material or clarification according to his answers.

Responsive TV is a newcomer and so far nothing much has been reported on its performance. Most of its applications have been reported in the area of teaching certain skills. According to the promotional literature[98], a University of California (Los Angeles) research study has demonstrated that this system reduces the learning time by a 30 percent minimum and increases retention levels as high as 56 percent.

Though much remains to be investigated, especially about the cost of producing interactive programs and learning performance, responsive TV seems to have some great potential. One of the most attractive features is that the responsive unit can be attached externally to any conventional television receiver or monitor, converting it into a responsive system. Though the cost of the response unit is in the neighborhood of $700-800 there is no reason why it could not be brought down in the range of $200-250 if mass usage is contemplated.

3. PUBLIC BROADCASTING PROGRAM DISTRIBUTION AND NETWORKING REQUIREMENTS

As is evident from the earlier discussions in this memorandum, Public Broadcasting is relatively new as far as a national construct goes. It is expanding, and as a General Electric Study[99] investigating satellite systems to meet the needs of public broadcasting comments, "the expectations for the future are not in the terms of firm requirements but in future possibilities". However, as one notices from earlier discussions, a national and subnational program distribution and networking service is needed as many ETV stations would go broke if they had to produce all the programming that they broadcast. There is a need to make available to local stations program of a quality and kind not possible through local production, and to provide instantaneous nationwide coverage of an event or issue which is deemed worthy of simultaneous broadcasting.

The current and expected needs of educational broadcasting, which is comprised of both public and instructional broadcasting, can be categorized as:

(1) Distribution of program material to existing and future educational radio and television broadcast stations, CATV headends, and community TV and low-power broadcast stations in areas where the geography prohibits the growth of conventional broadcasting.

(2) Distribution of supplemental as well as core program material to schools, hospitals, ITFS headends, instructional networks and other educational centers for instructional purposes and integration into curricula.

As mentioned earlier, in this memorandum, the authors have concerned themselves primarily with requirements for public broadcasting. The requirements for the instructional segment will be discussed in a forthcoming memorandum.

Public television coverage at present is such that some 204 stations disseminate signals which are capable of reaching some 74 percent of the American people, although the viewing audience is currently limited to approximately 33 million people each week.[17] Though some 20 new public television stations are expected to become operational before the end of 1973, the coverage provided by public broadcasting networks will be far from satisfactory because according to the projections of CPB and NAEB, more than 330 stations will be needed to provide service to 95 percent of the American people.[100]

In the case of radio, the 92 major public radio stations are clustered in 32 states, the District of Columbia, and Puerto Rico. However, the signals of the total complex of 457 stations are estimated to cover 75 percent of the population. The program distribution service should be able to interconnect the existing and anticipated stations, keeping in mind the state network interconnections, the shared nature of PTV and ITV operation for the majority of the stations, and the growing CATV facilities.

The current organization of public broadcasting--program acquisition and distribution policies, regional and state networks, and the diverse ownerships of ETV stations--imposes a set of program distribution requirements very different from that of commercial network program distribution. Two of the major differences relate to the need for operational flexibility in terms of national, regional and statewide distribution, and the need for multiple-point program origination. In commercial network program distribution, the distribution is mostly national and sub-national (regional) and the program origination points are few--generally two, one on the East Coast (New York) and the other on the West Coast (Hollywood).

Currently, negotiations between the PBS and AT&T are in progress for an interim dedicated terrestrial network so that PBS can provide a weekly schedule of approximately 50 hours of programming as opposed to only 15 hours of programming per week that it is distributing currently. Some 109 AT&T "drop" points are planned in a round robin configuration which permits some 28 stations to originate programming to feed national, regional and statewide networks which interconnect an additional 98 ETV stations.[100] Any alternate design for program distribution and interconnection would have to provide at least similar flexibilities. Figure 13 shows the locations of 28 program originating stations.

As far as public radio is concerned, the nature of program distribution and networking requirements are very much the same. The design should be able to offer national, regional and statewide distribution options and interconnect the existing 92 affiliates of the NPR, a number which is expected to grow to some 117 by the end of 1971, and allow multi-point

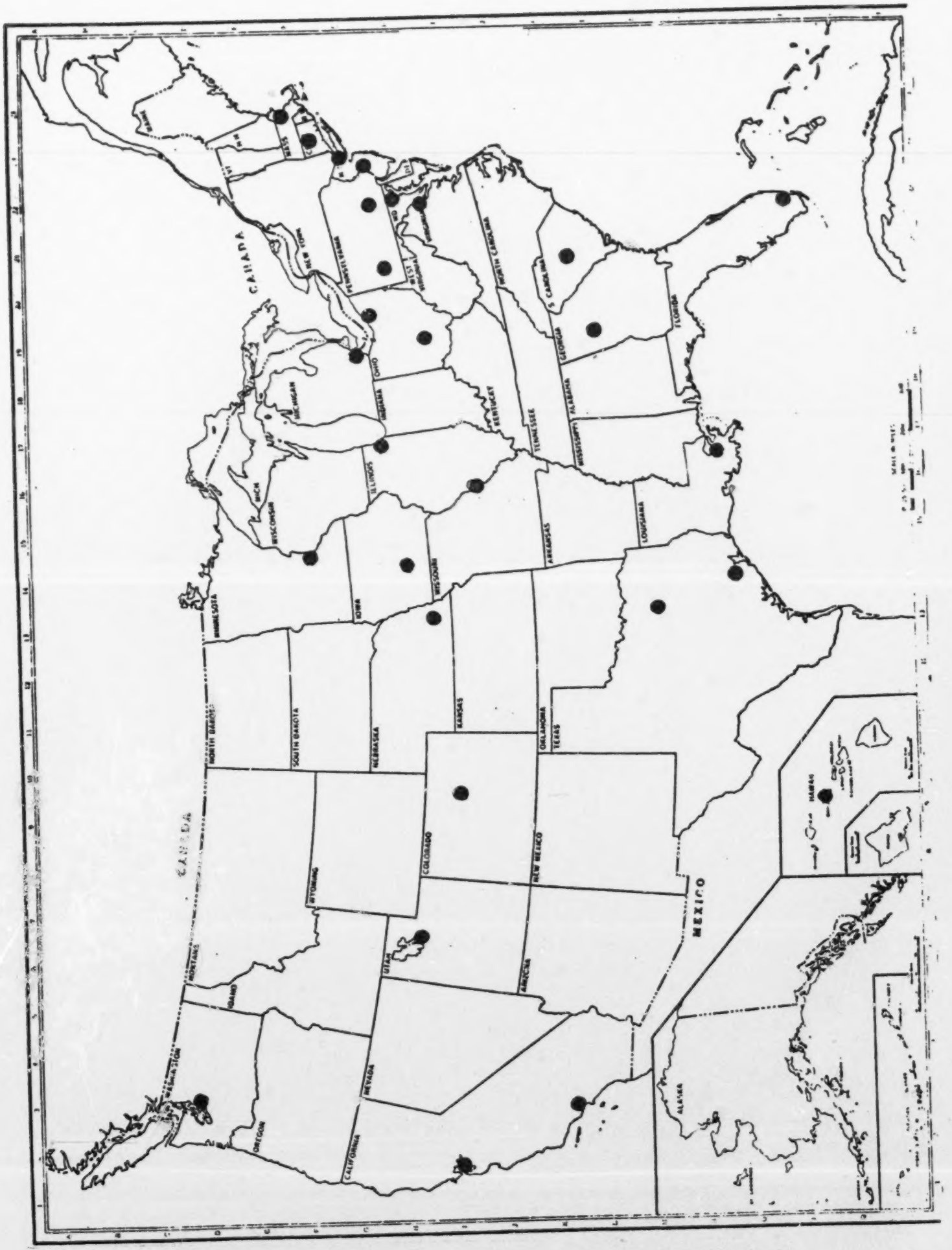

Figure 13. PROPOSED PUBLIC BROADCASTING ORIGINATION POINTS [Ref. 100]

program originations from 28 stations (Figure 13) throughout the country.[19] Though today there are no regional public radio networks in operation, the NPR anticipates that two such networks will be required by 1972 and an additional two or three regional systems can be expected by the mid-1970's.[19]

The authors believe that any design for public radio and television networking and program distribution must recognize and preserve regionality both in the configuration of the network and in program origination. This is in contrast to the belief by some that "regional programming", that is, something exclusively of interest to audiences within a region, a myth.[35] Cultural, geographic and ethnic differences should not go unserved because catering to the minority interests and separate audiences that constitute, in the aggregate, American society has always been cited as a potentially important function for public broadcasting. One must also not forget that a large number of the ETV and ER stations have an instructional objective and their programming is mostly selected on a local or regional basis.

Another important factor that influences the design of alternatives is that the U.S.A. extends over roughly 115 degrees of longitude. There are five time-zones within the country--Eastern, Central, Mountain, Pacific, and one covering Alaska and Hawaii. It would be desirable to provide, as far as possible, the same program at the same local time anywhere in the U.S. Figure 14 shows the way this could be accomplished by using terrestrial links whereas Figure 15 shows the time-zone operations by satellite links only. However, there is a trade-off between the optimal time-zone coverage and the cost incurred in terms of the additional terrestrial links or satellite RF channels. The customary practice is to provide the same program packages to the Eastern and Central time-zones, and another to the Mountain and Pacific time-zones. PBS has planned two delay centers for their interim terrestrial interconnection facility--one in Denver to provide coverage of the Mountain zone, and one in Los Angeles to cover the Pacific time-zone. However, it seems that two identical program packages displaced by two hours from each other would be adequate to take care of time differences.

PBS has specified its requirements for a satellite distribution service as two full-time, non-preemptible channels with adequate backup for sun outage, eclipse operation and potential transponder failure. These channels will permit PBS to deliver a national programming service providing ore single package to the Eastern and Central time-zones and another package, similar to the previous one but displaced in time by three hours, for the West Coast, i.e. Pacific time-zone.[100] The Mountain states will be served by a local delay center at Denver and through the terrestrial facilities, leased by the Rocky Mountain Public Broadcasting Network (RMPBN). NPR has stated similar requirements for the public radio, i.e. a time-delayed package for the Western time-zones.

In addition to these channels, primarily needed between 6 A.M. to 12 P.M. local standard time, public broadcasting will also require distribution facilities on a part-time and occasional basis. PBS estimates that some 31 hours per week will be required for regional programming, special time-delays, and program assembly.[100] Currently, the PBS network splits into five regional networks for one hour per week of prime time regional programming. However, PBS can schedule the network split to reduce its maximum requirement to one additional channel hour per day, five days per week.

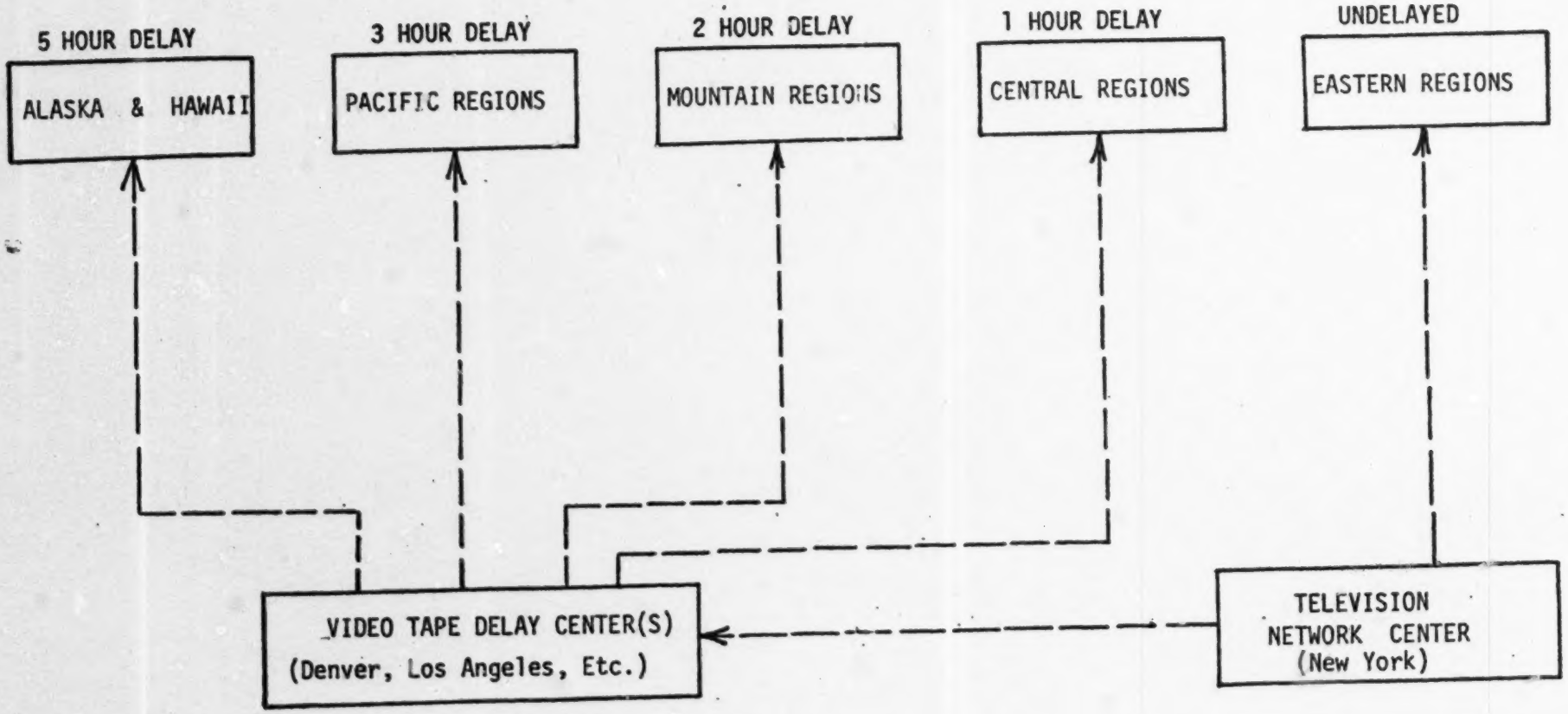

Figure 14. TIME-ZONE OPERATIONS BY TERRESTRIAL LINKS ONLY

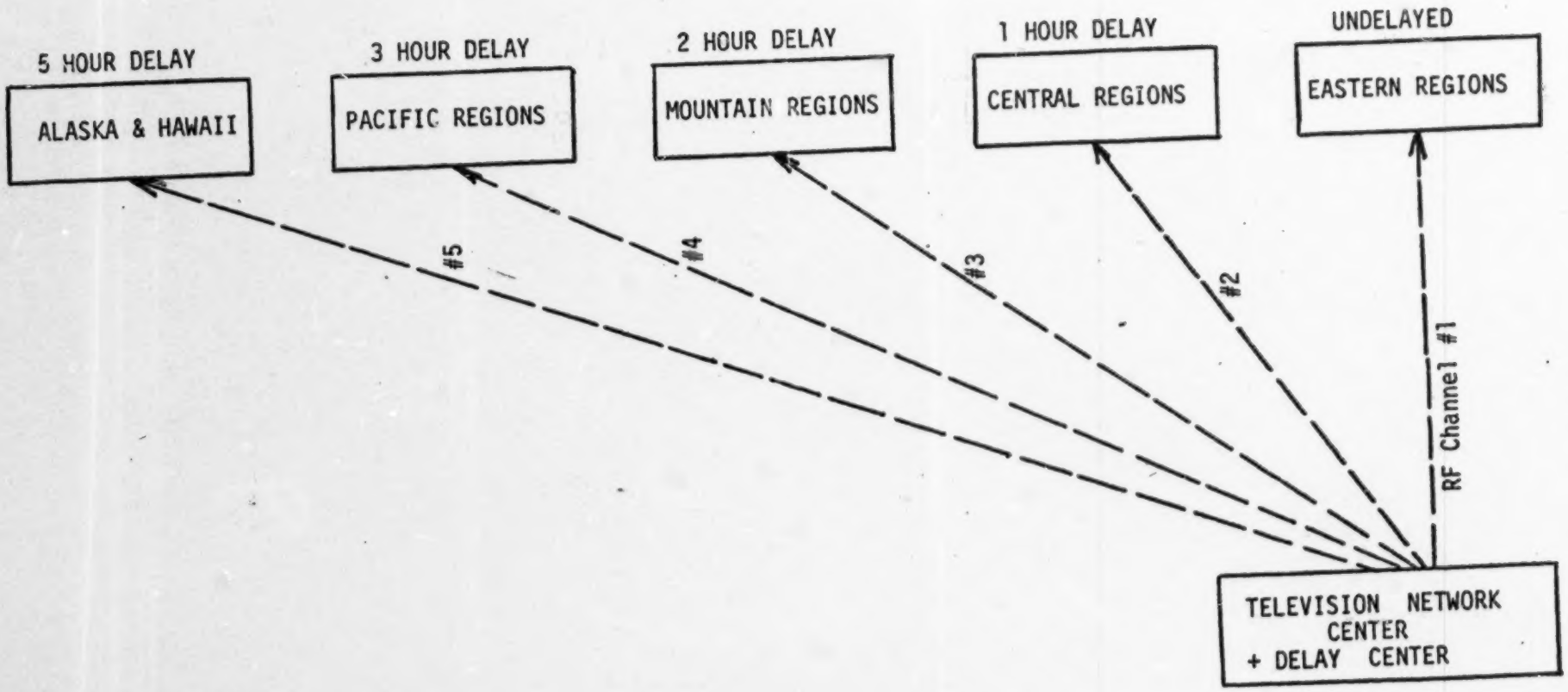

Figure 15. TIME-ZONE OPERATION BY SATELLITE LINKS

In addition to provision for regional splits, special time-delays in the two time-zones not delayed by the basic service would be needed to accommodate supplemental type instructional programming such as Sesame Street and its new reading program follow-up within local school schedules. PBS has estimated its requirements for special time-delays as two additional hours per day for five days per week.[100] PBS and its member stations are developing an expanded series of public affairs programs that would draw on member stations. To permit program assembly, part-time access to a channel will be required. PBS estimates that it would require some two hours per day, seven days a week, with two extra hours on Fridays. Also, there is a need for occasional access to a satellite channel for covering unexpected special events that cannot be accommodated within the full-time or supplemental services described above.

Present national communication facilities cannot transmit from remote areas efficiently and at low cost. In order to broadcast events that occur in such areas, significant leadtime is required to build facilities at a cost that often makes it unreasonable to cover the event. This often prohibits live coverage of special interest, unexpected events unless they happen to be within the neighborhood of large cities. Mobile earth stations offer a distinct possibility for live coverage of such events. However, the requirements for supplemental and occasional services that are listed above can at most be said to be short-term ones. Any design for the network should be flexible enough to meet the varying supplemental and occasional requirements.

Similar requirements for supplemental and occasional service also exist for public radio. The authors believe that one full-time "channel" between 6 A.M. - 12 P.M. LST is justified here because many affiliates of NPR would like to provide supplementary service via Subsidiary Communications Authorization (SCA) channels.

It should be kept in mind that the above requirements have been stated from the viewpoint of a single network service. However, some people in PBS have started thinking about a second "network" service for the simple reason of providing greater diversity in programming and a possible university of the air. Such a service is a distinct possibility in the late 1970's with local dissemination being provided by CATV, "second" TV stations, etc. Today, some 12 TV markets are served by two or more public television stations--a number that could ultimately grow to 41 when all reserved ETV allocations are utilized. A second service could also provide additional programming to meet the specific needs of cultural and ethnic minorities such as Negroes, American Indians, Spanish Americans, Eskimos, etc. It may be desirable to have second services on a regional basis--such as one for Appalachia, one for Alaska, one for the Rocky Mountains, and one for the Southwest for migrant workers and Mexican-Americans. At this time, it is hard to say which "second" services would develop. However, a nationwide "second" service in the late 1970's remains a distinct possibility and would almost double the distribution requirements.

In addition to program distribution to educational radio and TV transmitters and CATV headends, there is a need to disseminate the same as well as special interest programs somehow to some 50 million American people who can not currently receive educational television and radio

and also to schools for integration into their curricula. For this purpose, the authors envision a "medium quality" television service to small economical receivers, typically with a 9-12 foot antenna-receiver which feeds signals to either closed-circuit instructional installations or ITFS headends, or to low power unattended broadcast stations for rebroadcast. To achieve this kind of service, one would have to use a frequency band not subject to the flux density limit of 152 dbw/m^2 per 4 kHz, e.g. 2.5 and 12 GHz, and use relatively higher power satellites than the ones currently in use in the Intelsat series. These small earth-terminals could be located on individual school roofs, instructional centers and in areas/communities which do not have any access to public broadcasting signals and where there is also a need to disseminate other types of information for health-care, professional development, etc.

The three areas which appear to need such a service are Alaska, the Rocky Mountains, and Appalachia. A study by the General Dynamics conducted for NASA has mentioned that some 438 such terminals would be required in Alaska and 2,978 in the Mountain states, for adequate coverage.[102] No information on probable location requirements for Appalachia is available and it is hoped that a future study will be able to set these requirements. It would be desirable that the same program package that is being distributed to standard broadcast stations and CATV headends is also delivered to these small terminals with provisions for daytime substitution of regional programming specially tailored to the needs of these areas. It should be noted that in many remote areas/communities it should be possible to share the small earth-terminal located at the school for general public use provided the receiver is designed for multi-channel operation.

So far, the requirements have been discussed in terms of "channels". Now it becomes necessary to specify the channel bandwidth, special provisions such as order wire and stereo sound, picture quality, etc. For television networking and program distribution purposes, the "channel" would consist of a 4.2 MHz standard video channel, an order wire for supervisory and control purposes and two 15 kHz sound channels to provide stereophonic sound. PBS has listed stereo sound with a standard video channel as a requirement. The authors agree with this requirement from the long-term point of view. As far as the radio "channel" is concerned, it is composed of two 15 kHz channels to provide stereophonic capability. Though NPR has not mentioned any need for an order wire facility, the authors feel that an accompanying order wire facility would be desirable, in view of the nature of the NPR networking design which is much different than those of commercial radio networks. Three kHz audio channels would suffice as "order wires" for both TV and radio "channels".

Currently radio networking and TV networking is limited to rather low quality audio based on 3.5 kHz to 5 kHz wide channels due to the unavailability of high quality long-distance terrestrial facilities for audio. NPR presently pre-records high quality and stereophonic programs and distributes them by mail. However, satellites offer a distinct possibility for distribution of high quality (15 kHz) stereophonic audio signals and would permit real-time transmission of such programs.

The performance objectives for a satellite networking service for television has been investigated thoroughly and are recorded in the "Green Books" of CCIR. Signal-to-noise ratio (the ratio of the peak-to-peak luminance signal to the rms value of the random noise signal) should not be less than 55 db with noise being weighed as appropriate to the method of modulation (7.0 db for frequency modulation for 525 line composite video color signal).

It should be noted that the signal-to-noise ratios of picture sources are themselves in the range of 46-50 db[103]--50 db for vidicon type cameras, 46 db for Image-Orthicon cameras, and 46 db for third generation recording of vidicon signals. When the in-studio transmission paths, terrestrial intercity links (depending upon earth station location), satellite transmission, and the SNR for the broadcast transmitter are taken into account, the addition of noise powers results in an overall SNR weighted of 44.2 db at the output of the local transmitter prior to propagation and reception. This would mean a picture quality half-way between "Excellent" and "Fine" or TASO Grades 1 and 2.[104, 109] The same performance objective would apply for educational television program distribution via CATV in urban and suburban areas.

At the present time there are no agreed upon standards for direct satellite distribution to school-roof and community installations. The General Electric study[99] for PBS has chosen the SNR requirement to be 45 db (peak-to-peak video/rms noise-weighted). The noise powers, when added, result in an overall SNR weighted of 42 db at the output of the low-power RF modulator which feeds cable in case of multi-channel operation. This too would mean a picture quality half-way between "Excellent" and "Fine" or TASO Grades 1 and 2 at the output of the modulator. If the picture quality requirement is taken as TASO Grade 2 for school rooftop installations (at the output of the modulator), the space-link SNR should be 43.4 db. The authors have decided to choose this as the space-link SNR requirement instead of 45 db as proposed in the G.E. study. Tables 11 and 12 show the program distribution and networking requirement for public radio and television in a concise form.

TABLE 11

PUBLIC TELEVISION SERVICE

SOURCES

PUBLIC BROADCASTING SERVICE (PBS)
EASTERN EDUCATIONAL TELEVISION NETWORK (EETN)
CENTRAL EDUCATIONAL NETWORK (CEN)
SOUTHERN EDUCATIONAL COMMUNICATIONS ASSOCIATION (SECA)
MIDWESTERN EDUCATIONAL TELEVISION (MET)
ROCKY MOUNTAIN PUBLIC BROADCASTING NETWORK (RMPBN)
WESTERN EDUCATIONAL NETWORK (WEN)
NATIONAL EDUCATIONAL TELEVISION (NET)
CHILDRENS TELEVISION WORKSHOP (CTW)

DESTINATIONS

207 PTV/ITV STATIONS FOR REDIFFUSION VIA 109 FEED POINTS; ADDITIONAL 98 TO BE FED THROUGH STATE NETWORKS.

CABLE TELEVISION (CATV) HEADENDS.

COMMUNITY AND SCHOOL RECEIVERS THROUGH DIRECT DISTRIBUTION/BROADCASTING FROM SATELLITE(S) IN REMOTE AREAS OF ALASKA, MOUNTAIN STATES AND APPALACHIA WHICH DO NOT HAVE ACCESS TO ANY ETV SERVICE.

SYSTEM REQUIREMENTS

(A) PROGRAM DISTRIBUTION

- 50 STATE COVERAGE
- NATIONAL AND SUB-NATIONAL DISTRIBUTION PROVISIONS
- DELAYED PROGRAMMING FOR PACIFIC AND MOUNTAIN TIME-ZONES
- PROVISION FOR MULTIPLE POINT ORIGINATIONS
- PROVISION OF AN ORDER WIRE FOR EACH CHANNEL
- PROVISION OF PART TIME USE OF ADDITIONAL CHANNELS FOR SPECIAL EVENT COVERAGE, SPECIAL TIME-ZONE DELAYS, PROGRAM ASSEMBLY, REGIONAL SPLITS ETC. IN ADDITION TO TWO SATELLITE CHANNELS DURING 0600-2400 HRS EVERY DAY.
- TWO 15-kHz SOUND CHANNELS FOR STEREOPHONIC SOUND
- SPACE LINK CONFORMING TO CCIR RECOMMENDATIONS, i.e. A SNR OF 55 dB

(B) DIRECT DISTRIBUTION TO COMMUNITY INSTALLATIONS

- SUB-NATIONAL COVERAGE - ALASKA, ROCKY MOUNTAINS AND APPALACHIA
- SEPARATE CHANNEL FOR EACH AREA
- PROVISION FOR NATIONAL AS WELL AS REGIONAL PROGRAM ORIGINATION
- PROVISION FOR PART-TIME USE OF ADDITIONAL CHANNELS FOR EVENINGS AND WEEKENDS
- ONE 15-kHz SOUND CHANNEL FOR MONOPHONIC SOUND
- SPACE LINK WITH A SNR OF 43.5 dB TO PROVIDE TASO GRADE 2 SIGNAL

TABLE 12

PUBLIC RADIO SERVICE

SOURCES

NATIONAL PUBLIC RADIO (NPR)

NATIONAL EDUCATIONAL RADIO NETWORK (NERN)

REGIONAL RADIO NETWORKS
(CURRENTLY UNDER DEVELOPMENT)

DESTINATIONS

92 MAJOR EDUCATIONAL RADIO STATIONS

CATV HEADENDS

COMMUNITY AND SCHOOL RECEIVERS, LOW POWER REBROADCAST TRANSMITTERS THROUGH DIRECT SATELLITE DISTRIBUTION/BROADCASTING IN REMOTE AREAS OF ALASKA, MOUNTAIN STATES AND APPALACHIA WHICH DO NOT HAVE ACCESS TO ANY ER SERVICE.

SYSTEM REQUIREMENTS

(A) PROGRAM DISTRIBUTION

- 50 STATE COVERAGE
- NATIONAL AND SUB-NATIONAL PROGRAM DISTRIBUTION PROVISION
- PROVISION FOR MULTIPLE POINT ORIGINATIONS
- DELAYED PROGRAMMING FOR MOUNTAIN AND PACIFIC TIME-ZONES
- PROVISION OF A 3.5 kHz ORDER WIRE WITH EACH OF THE TWO "CHANNELS" CONSISTING OF TWO 15-kHz AUDIO CHANNELS FOR STEREOPHONIC SOUND
- PROVISION FOR PART TIME USE OF ADDITIONAL CHANNELS FOR REGIONAL SPLIT, PROGRAM ASSEMBLY AND SPECIAL EVENT COVERAGE
- SPACE LINK WITH A SIGNAL TO NOISE RATIO OF 50 dB

(B) DIRECT DISTRIBUTION TO COMMUNITY INSTALLATIONS

- SUB-NATIONAL COVERAGE - ALASKA. ROCKY MOUNTAINS AND APPALACHIA
- SEPARATE CHANNEL FOR EACH AREA
- PROVISION FOR REGIONAL AS WELL AS NATIONAL MULTI-POINT PROGRAM ORIGINATIONS
- A CHANNEL-WIDTH OF 15 kHz
- SPACE LINK WITH A SNR OF 43 dB

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APPENDIX A

ANALYSIS OF EDUCATIONAL TELECOMMUNICATIONS NEEDS: SERVICE CATEGORIES

For the purposes of analysis, following Lockheed's "Information Transfer Systems Requirements Study"[1], educational/instructional telecommunications requirements can be grouped under the following three broad service categories:

(1) Information Dissemination and Broadcast Services

This type of service can be characterized by those systems which provide transfer of information between many terminals and one centralized terminal. Messages are originated by human beings in voice, graphic and pictorial form for immediate consumption of human beings. It is essentially a one-way transfer of information on a point-to-multipoint basis as found in conventional radio and television broadcasting, Instructional Television Fixed Service without interaction, etc.

(2) Interactive Telecommunications Services

This could be further broken into two categories: (1) systems which involve interaction between two or among several human beings, and (2) systems which involve interaction among man and machine. Both categories require two-way transmission circuits.

Systems and/or services such as teleconferencing via picture-phone and telephone, talk-back television teaching systems, etc. come under the first category. The second category of services is typified by the systems/services in which a large number of terminals are capable of making an inquiry to a single repository of information which is capable of retrieving the requested information and responding to the inquiry. The central system can also have the capability, depending upon the system requirements, to digest the data, making computations on these data and provide the answer. One thing that should be remembered here is that the interaction takes place at human speeds at a relatively slower rate than the incoming data. Examples of such services are remotely located (from the main processor) Computer Assisted Instruction/Computer Managed Instruction (CAI/CMI) terminals, remote medical diagnosis, information search, remotely located on-line, time-shared terminals for computer-aided problem solving and scientific information processing, etc. This type of service would in most cases require two-way point-to-point communication. Channel capacity requirements, in general, would be asymmetrical.

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[1] Sedlacek, W. C. et al., "Final Report--Information Transfer Systems Requirement Study", NASA CR-73421, Lockheed Missiles and Space Company, Sunnyvale, California, (March 1970).

In one direction, data entry from a key-board or light pen, would be in the range of 12-150 bits/second, whereas in the other direction (from the central terminal or processor to the terminals interfaced with the many inquirers) data rate requirements could be anywhere between 75-9600 bits/second depending upon the type of interface that is employed--teletype, high speed Cathode Ray Tube (CRT), serial impact printer or non-impact printing devices.

(3) Computer Interconnection Services

This category of services includes time-sharing in the strictest sense of the term, that is, it has the characteristic of sharing a computer's time among a group of users and is closely allied to the inquiry and response described in the interactive services except for the fact that transmission rates are much higher and interaction is not limited by the human capacity to respond in terms of speed. Computer resource sharing is not a new development. However, in most cases, this is thought of only in terms of sharing processing or memory. On-line developments, which need not necessarily be time-shared, are opening up cooperative and remote use of programs which are locally developed. This avoids the expensive process of duplicating the computer programs in several locations. The communication circuit requirements are of the two-way point-to-point type. Data rate requirements for the circuit could be symmetrical as well as asymmetrical depending upon the particular system configuration. Data rate requirements depend upon whether interaction is taking place at "electro-mechanical" speeds or is occurring at "electronic" speeds. Data terminals operating at electro-mechanical speeds include line-impact printers, card punch/readers, paper tape punch/readers, and mechanical digital plotters. Data terminals operating at electronic speeds include buffered magnetic tape drives, magnetic disc drives, non-impact printers, graphic CRT and computer based terminals. Transmission requirements could be as high as 50 kilobits/second for the type of systems that are in use today.

APPENDIX B

SOME COMMENTS ON THE SUITABILITY OF EIGHT DOMESTIC SATELLITE PROPOSALS FOR MEETING PUBLIC BROADCASTING REQUIREMENTS

The Federal Communications Commission in its Report and Order, in the matter of Domestic Communication Satellite Systems (Docket 16495), adopted on March 20, 1970, declared that applicants proposing multipurpose domestic communications satellite systems should discuss the terms and conditions under which satellite channels will be made available for noncommercial broadcast networks, if the applicant's proposed service includes commercial television and radio program distribution. March 15, 1971 was the last date for submission of proposals to the FCC. Eight separate proposals have been filed with the FCC by a combination of aerospace companies and common carriers for authorizations to construct domestic satellite facilities. Table 1 presents a brief summary of these proposals as well as their offerings, if any, for educational purposes.

One should remember that if total coverage to Alaska is desired, the satellite(s) should be placed west of 115° west meridian (for a minimum elevation angle of 5°), whereas the coverage of the eastern part of the United States with a minimum of 5° of elevation angle requires satellite(s) to be placed east of 137° west meridian.[1] All the domestic proposals contemplate satellite placements within the geostationary arc defined by 94°-125° W. Of a total of 21 satellites proposed to be orbited initially, nine fall within the arc 115°-125° W. and thus are capable of being seen simultaneously from the most eastern part of the United States as well as the most western part of Alaska (Table 1)*. The only proposal that does not contemplate placing a satellite in the arc 115°-137° W. is from Hughes Aircraft Company and thus it does not fulfill the PBS requirement for the total U.S. coverage, including Alaska, Hawaii and Puerto Rico.

As far as the operational frequency is concerned, all the proposals are confined to uplinks of 5.925-6.425 GHz and 12.75-13.25 GHz and downlinks of 2.550-2.690 GHz, 3.7-4.2 GHz, 6.625-7.125 GHz and 11.7-12.2 GHz. All proposals contemplate using conventional 4/6 GHz operation. Fairchild

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[1] "The RAND Sync-Sat Calculator", The RAND Corporation, RM-5228-NASA, Santa Monica, California, (1967).

* All the nine satellites cannot be accommodated in this small arc (115°-125° W.) even with the most optimistic orbit spacing criteria, in view of the fact that most satellites contemplate using the same frequency bands (4 & 6 GHz, 12 & 13 GHz).

Table 1

SUMMARY OF DOMESTIC SATELLITE PROPOSALS

	AT&T/COMSAT	COMSAT	MCI-LOCKHEED	FAIRCHILD-HILLER
SYSTEM				
No. of Satellites	3 in Orbit 1 ground spare	3 in Orbit 1 ground spare	2 in Orbit 1 ground spare	2 in Orbit 1 ground spare
Orbit Locations [Longitudes]	94°, 104°, 119°W.	99°, 114°, 124°W.	114°, 119°W.	104°, 115°W.
SATELLITE				
Weight at Sync. Orbit	1600 lbs.	1600 lbs.	3900 lbs.	2905 lbs.
Spacecraft Size	110 inches in diameter 230 inches in height	110 inches in diameter 230 inches in height	8' x 5' x 6'[Stowed] x106'[unfurled]	9' in diameter[stowed] 25.3' in length
Stabilization	Spin	Spin	3-Axis [Momentum-wheels]	3-Axis [Momentum-wheels]
Station Keeping	Hydrazine Thrusters	Hydrazine Thrusters	Ion Propulsion Thrusters and Hydrazine Engines	Hydrazine Thrusters
Primary Power	~740 watts [solar cells on drum]	~740 watts [solar cells on drum]	4.4 kW [Solar Cell Array]	750 watts (solar cell cylinder)
Life Time	7 years	7 years	10 years	7 years
Launch Vehicle	Atlas Centaur	Atlas Centaur	Titan III D/Agena	Titan III C
COMMUNICATION SUB-SYSTEM				
Frequency Bands [Receive/Transmit]	5.925-6.425/3700-4.200GHz	5.925-6.425/3.7-4.2 GHz	5.925-6.425/3.7-4.2GHz 12.7-13.25/11.7-12.2GHz	5.925-6.425/3.7-4.2GHz 12.75-13.25/6.625-7.125GHz 2.5-2.69 Trans. Optional
Polarization	Linear	Linear	Linear	Linear
Number of Transponders	24	24	48 [24 for 6/4 GHz operation; 24 for 12 GHz operation]	120 [96 0.1w for narrow-beam point-to-point service; 24 for wide-area TV distr]
Usable Bandwidth per Transponder	34 MHz	34 MHz	36 MHz	34 MHz
Transponder Output Device	TWT	TWT	TWT	TWTs for Wide-area service; Solid State devices for narrow-beam point-to-point
E.I.R.P. per Transponder	33 dbW[beam-edge]	33 dbW[beam-edge]	34.5 at 4 GHz[beam-edge] 46 dbW at 12 GHz	36 dbW for narrow-beams 35.2 dbW for wide-area coverage at beam-center
EARTH STATIONS				
95-105' cooled T/R[G/T= 41.2 db/°K] 4/6GHz	5	2	--	6
42' cooled R/O[G/T= 35 db/°K] 4/6GHz	--	3	--	--
32' cooled T/R[G/T= 33 db/°K] 4/6GHz & 12GHz	--	--	20	--
32' cooled T/R [G/T= 31.5 db/°K] 4/6GHz	--	3	--	--
32' uncooled T/R[G/T= 29.0db/°K] 4/6GHz	--	25	--	--
32' uncooled R/O[G/T= 29.0db/°K] 4/6GHz	--	99	--	--
25' uncooled R/O	--	--	--	Over 100
PUBLIC SERVICE OFFERINGS	Willing to discuss with CPB the terms and conditions. Nothing Specific.	Willing to work out some sort of preferential service public broadcasting to meet the genuine requirements of the Corporation for Public Broadcasting[CPB]	Proposes to make available for experimentation in educational service, the equivalent of five TV channels without charge for a period of five years. Also plans to offer equal transmission capacity for the remaining satellite life at a fraction of regularly established rates.	[1] Two fully non-interruptable satellite transponder channels, at no-cost, to the Public Broadcasting Service; shared use of narrow-beam channels for "off-shore" locations of Alaska, Hawaii, Puerto Rico and Panama Canal zone; [2] Part-time, free-use, of two satellite transponder channels for health-care delivery throughout U.S.; [3] Free service of one or two instructional television channels from the satellite directly to a low-cost terminal for school or community use on 2.550-2.690 GHz band; [4] Free use of the spacecraft segment for a communication system for Alaska.

Table 1 (Continued)

	HUGHES AIRCRAFT COMPANY	RCA GLOBAL COMMUNICATIONS/ RCA ALASKA COMMUNICATIONS	WESTERN UNION TELEGRAPH COMPANY	WESTERN TELECOMMUNICATIONS.
SYSTEM				
No. of Satellites	2 in Orbit 1 ground spare	2 in Orbit + 1 at a later date 1 ground spare	3 in Orbit 1 ground spare	2 in Orbit + 1 at a later date 1 ground spare
Orbit Locations [Longitudes]	100°, 103°W.	[114°], 121°, 125°W.	95°, 102°, 116°W.	113°, 116°, [119°]W.
SATELLITE				
Weight at Sync. Orbit	452.5 lbs.	638 lbs.	452.5 lbs.	727 lbs.
Spacecraft Size	73 inches in diameter ..... in length	.....	73 inches in diameter ..... in length	72 inches in diameter .....
Stabilization	Spin	Spin/3-Axis [Not decided]	Spin	Spin
Stationkeeping	Hydrazine Thrusters	Hydrazine Thrusters	Hydrazine Thrusters	Hydrazine Thrusters
Primary Power	220 Watts [Solar cell on the spinning drum]	Aprox. 305 Watts [Solar cells]	220 Watts [Solar cells on the spinning drum]	270 Watts [Solar cells on the spinning drum]
Life Time	7 Years	7 Years	7 Years	7 Years
Launch Vehicle	Thor-Delta M-6T	Thor-Delta 904/ Atlas/TE-364-4	Thor-Delta M-6T	Delta 2914
COMMUNICATION SUB-SYSTEM				
Frequency Bands [Receive/Transmit]	5.925-6.425/3.7-4.2 GHz	5.925-6.425/3.7-4.2 GHz 12/13 GHz Experiment	5.925-6.425/3.7-4.2 GHz	5.925-6.425/3.7-4.2 GHz 12.75-13.25/11.7-12.2 GHz
Polarization	Linear	Linear	Linear	Linear
Number of Transponders	12	12 for 4/6 GHz operation 12 for 12/13 GHz operation	12	6 for 4/6 GHz operation 6 for 12/13 GHz operation
Type of Transponder	Linear, Frequency Translation	Linear, Frequency Translation	Linear, Frequency Translation	Linear, Frequency Translation
Usable Bandwidth per Transponder	36 MHz	36-37 MHz	36 MHz	36 MHz
E.I.R.P. per Transponder	33.1 dbW for Cont. U.S. 26 dbW for Alaska & Hawaii	35 dbW for cont. U.S. 26 dbW for Hawaii & Puerto Rico	33.1 dbW for Cont. U.S. 24 dbW for Alaska & Hawaii	32 dbW for cont. U.S. [for 4 GHz operation] 38 dbW for cont. U.S. [12 GHz] 26 dbW(4GHz) for Alaska & Hawaii
EARTH STATIONS				
98' cooled T/R* [G/T= 36.7 db] 4/6GHz	2	1	.....	.....
60' cooled T/R [G/T= 36.2 db] 4/6GHz	.....	.....	.....	3
45' uncooled T/R [G/T= 37.5 db] 12/13GHz	.....	.....	.....	1
45' cooled T/R [G/T= 32.3 db] 4/6GHz	.....	.....	7	.....
35'/32' cooled T/R [G/T=31.5db] 4/6GHz	.....	13	.....	.....
35' uncooled R/O** [G/T=27.8db] 4/6GHz	Over 100	.....	.....	.....
20' uncooled R/O [G/T=25 db] 4 GHz	.....	Exact Number not known	.....	Exact Number not known
18' uncooled R/O [G/T=27.1 db] 12GHz	.....	.....	.....	Exact Number not known
15' uncooled R/O [G/T=23 db] 4GHz	.....		.....	.....
PUBLIC SERVICE OFFERINGS	Two channels on first satellite with complete backup and no pre-emption. Pre-emptive rights on two channels on spare satellite. Free access to channels from any authorized ground station.	Two TV channels at reduced rates for ETV distribution. Public Radio program distribution on "piggy back" basis on the channels assigned for ETV. Promotional rates for experimental ITV services via standby satellite. Two TV channels for Alaska on regular rate basis.	Willing to offer one or more channels for ETV distribution if the FCC decides that it is in public interest that non-commercial ETV networks should be provided satellite channels without charge.	No cost or reduced cost channels for PTV networking.

*Transmit/Receive
**Receive Only

Hiller is the only one which has proposed a 2.5 GHz downlink with considerably higher E.I.R.P. (55 dbW) for low-cost reception ($2000 per terminal). It also proposes TV program distribution on 6.625-7.125 GHz. The only proposals that contemplate 12 GHz operation are those of Western Telecommunications and MCI-Lockheed. The E.I.R.P. of 4 GHz downlink beams covering the U.S. mainland (48 states) range between 32-36 dbW whereas those of beams covering Alaska and Hawaii are in the range 26-36 dbW. The Fairchild-Hiller proposal contemplates an EIRP of 34 dbW for the beam covering the mainland and 32 dbW for beams covering Alaska and Hawaii. For 12 GHz operation the EIRP's as proposed are 38 dbW for mainland and 42 for Alaska and Hawaii.

All the proposed systems are capable of satisfying the peak video signal to rms video noise objective of 55 but with earth stations of varying sensitivities. The figures of merit or G/T (Antenna gain to system temperature ratios) have a range 41.2 dB to 25 dB for 4/6, 7/13 and 12/13 GHz operation. Fairchild-Hiller's 2.5 GHz small earth-terminal coverage is designed around 49.8 dB SNR (7 feet diameter antenna), whereas MCI-Lockheed's 12 GHz service is designed to provide 54 dB SNR with an earth station with G/T = 33 dB/°K.

The costs of the earth-stations proposed by various applicants seeking authorization vary tremendously--$6.4 million for each of the five earth stations in the Comsat/AT&T proposals to $2,000 for 7' terminal for Fairchild-Hiller's 2.5 GHz service. An important thing to be kept in mind is the co-location of satellite earth-terminals and terrestrial redistribution/rebroadcast/broadcast facilities. In a great many urban areas co-location of 4 GHz facilities is virtually impossible due to interference from existing terrestrial common carrier facilities that share the same band. If the terminal is a transmit/receive type, transmitting at 6 GHz and receiving at 4 GHz, then another dimension to the difficulties in co-locating is added because now the terrestrial common carrier links have also to be protected from interference from the satellite earth-station transmitter. This often requires substantial investment in facilities (microwave links) connecting satellite earth-terminal and terrestrial redistribution/broadcast facilities. However, the co-locating problem is much less severe at 2.5 GHz and 12 GHz. Of these, the terminals operating at 12 GHz cost substantially more than those operating at 4 GHz. According to a GE study[2], the cost differential between a 4 and 12 GHz terminal is on the order of 1.4 to 1. There are also problems due to deeps fades that may occur on a local basis during heavy rains at 12 GHz.

As far as the requirement of multiple point originations is concerned, that is, the requirements that result in transmit/receive type earth stations at locations shown in Figure 12 (Section 2.8), all proposals are far from satisfactory. The MCI-Lockheed proposal is the closest, in that it provides some 12 of the 28 locations. Next are RCA and

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[2] Dysinger, J. H. et al., "An Investigation of Network Television Distribution Systems--Vol. I & II", General Electric Company, Philadelphia, Pennsylvania, (February 1971).

Western Telecommunications that satisfy seven and four locations respectively. The remaining five proposals provide for only two locations. Thus a major modification in the location of the sites for T/R stations would be needed if they were to satisfy the public broadcasting requirements outlined in Section 3.

Another thing that has to be kept in mind is that none of the proposals contemplate an orderwire and stereophonic high fidelity (2-15 kHz) channels accompanying the video signal. These would have to be accommodated by multiplexing them with the visual carrier and reducing the visual carrier's deviation. This may result in slightly higher G/T requirements at ground for a given 34 or 36-MHz satellite transponder, transponder power output, and certain performance criteria.

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